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Ishikura

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(54) **IMAGE FORMING APPARATUS**

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(73) Assignee: **Oki Data Corporation**, Tokyo (JP)

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Apr. 26, 2012 (JP) 2012-100717

(51) **Int. Cl.**

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B65H 1/26	(2006.01)
B65H 9/08	(2006.01)
B65H 1/00	(2006.01)

(52) **U.S. Cl.**

CPC ***B65H 1/266*** (2013.01); ***B65H 1/00*** (2013.01); ***B65H 9/08*** (2013.01); *B65H 2402/61* (2013.01); *B65H 2402/64* (2013.01); *B65H 2403/513* (2013.01); *B65H 2405/113* (2013.01); *B65H 2405/31* (2013.01)

(58) **Field of Classification Search**

CPC B65H 1/266; B65H 1/26; B65H 2405/31; B65H 1/04; B65H 2402/61; B65H 6402/64; B65H 2405/113; G03G 15/6502

USPC 271/145, 162, 164

See application file for complete search history.

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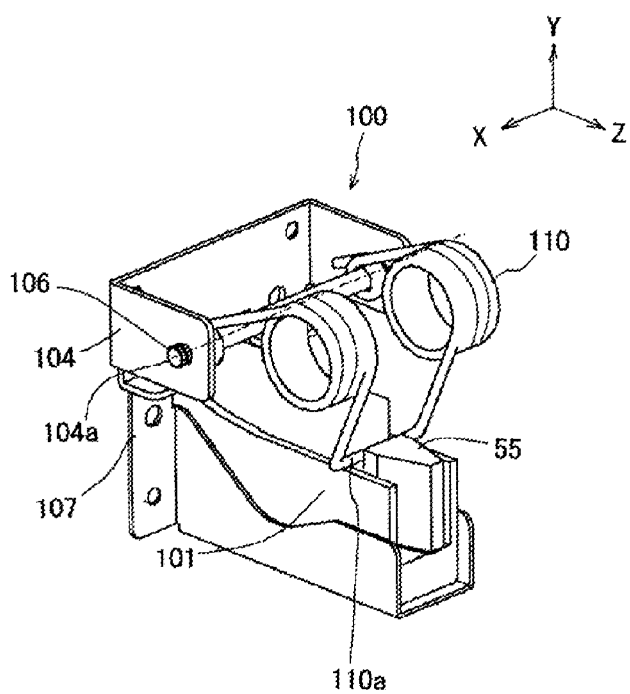
Primary Examiner — Prasad Gokhale

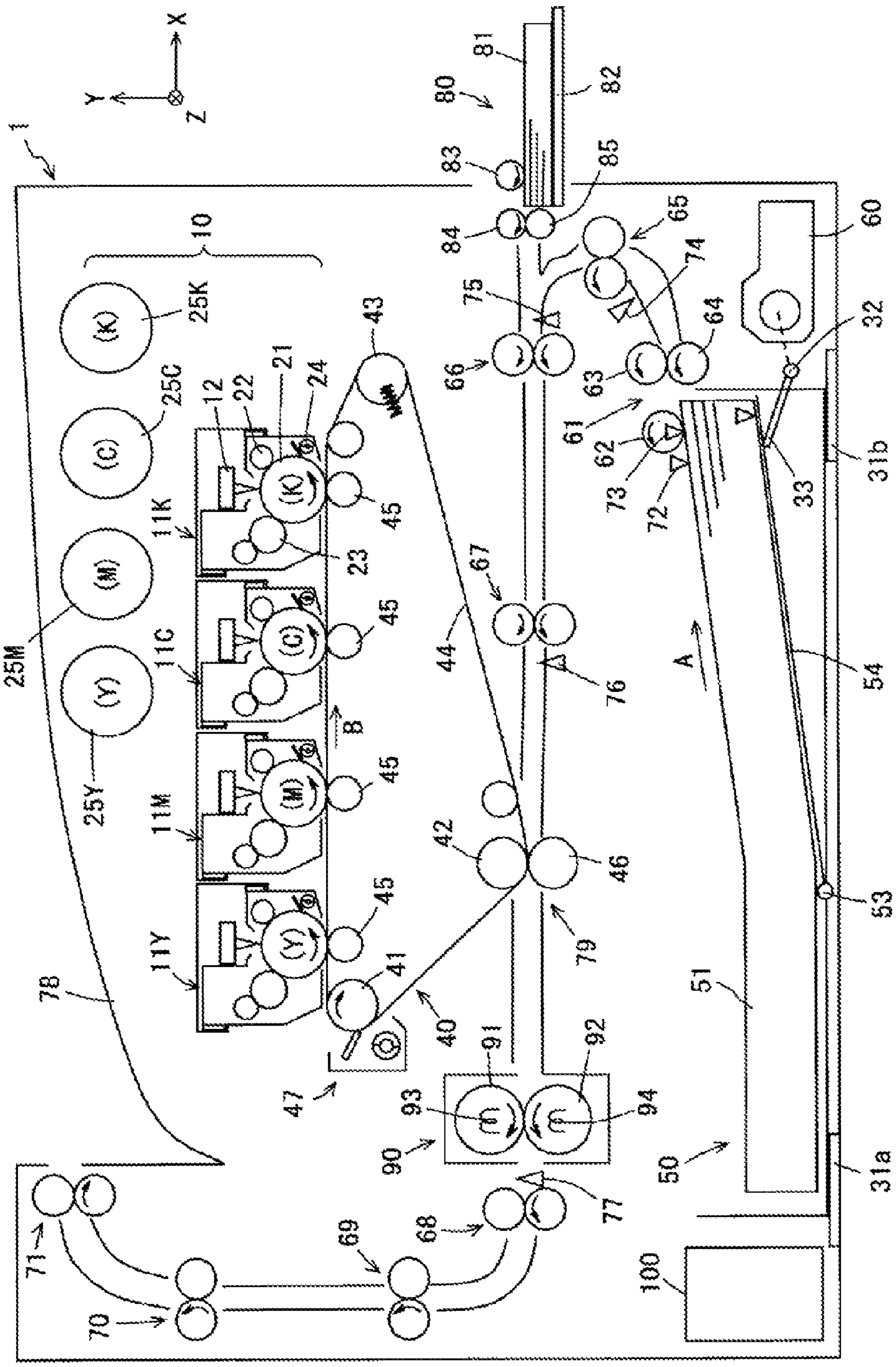
(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**

An image forming apparatus includes an engagement member provided on a sheet supply cassette, a biasing member with a first part, a second part and an elastic part formed of elastic material. The first and second parts are linked with the elastic part. The second part is supported to a apparatus main body with a swing shaft. The first part engaging with the engagement member so that the biasing member maintains a compressed state by the engagement member, and a guide restriction member provided on the apparatus main body restrict a movement of the first part.

20 Claims, 20 Drawing Sheets

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90
91
92
93
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31a
31b
32
33
A
B

Fig. 1

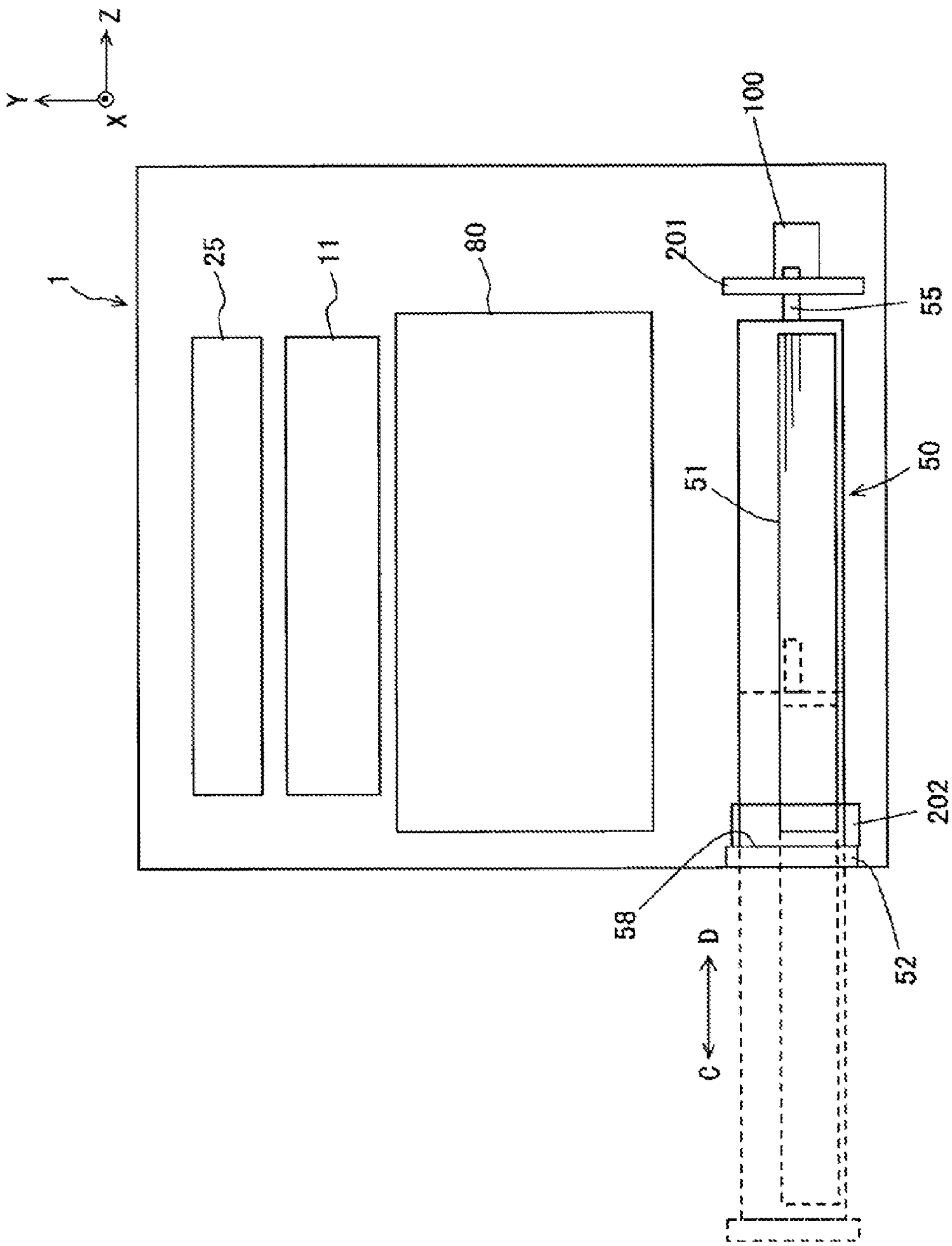


Fig. 2

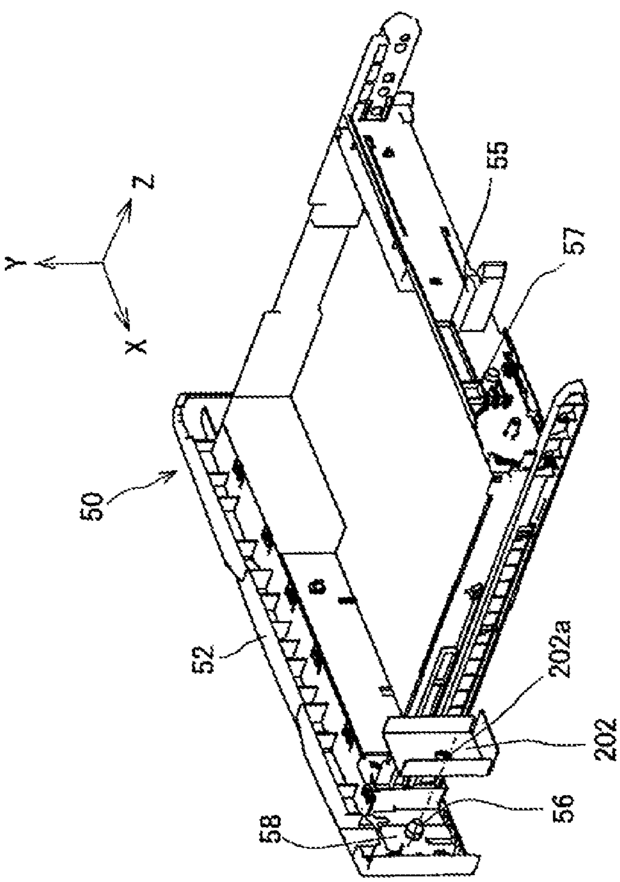


Fig. 3B

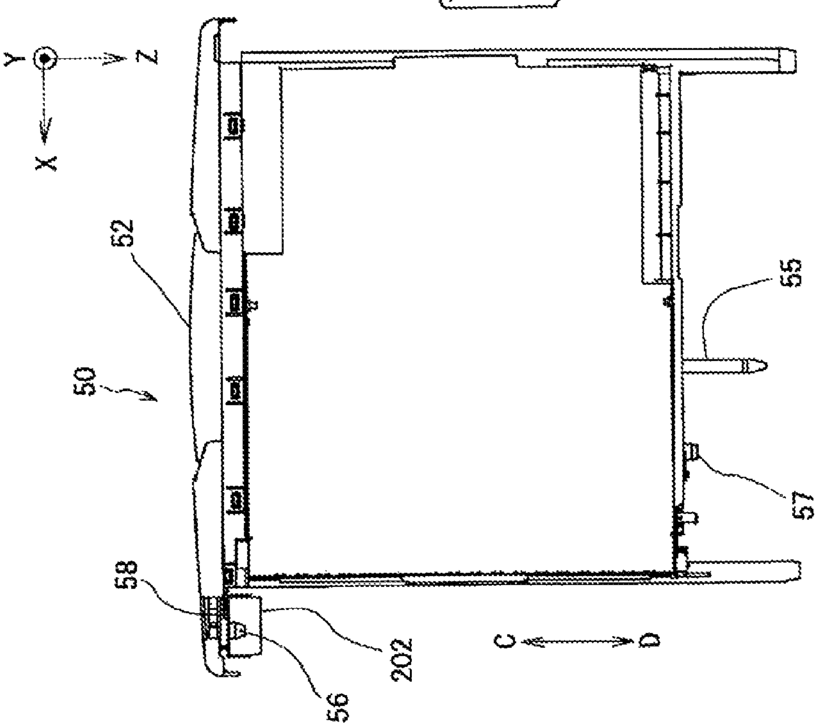
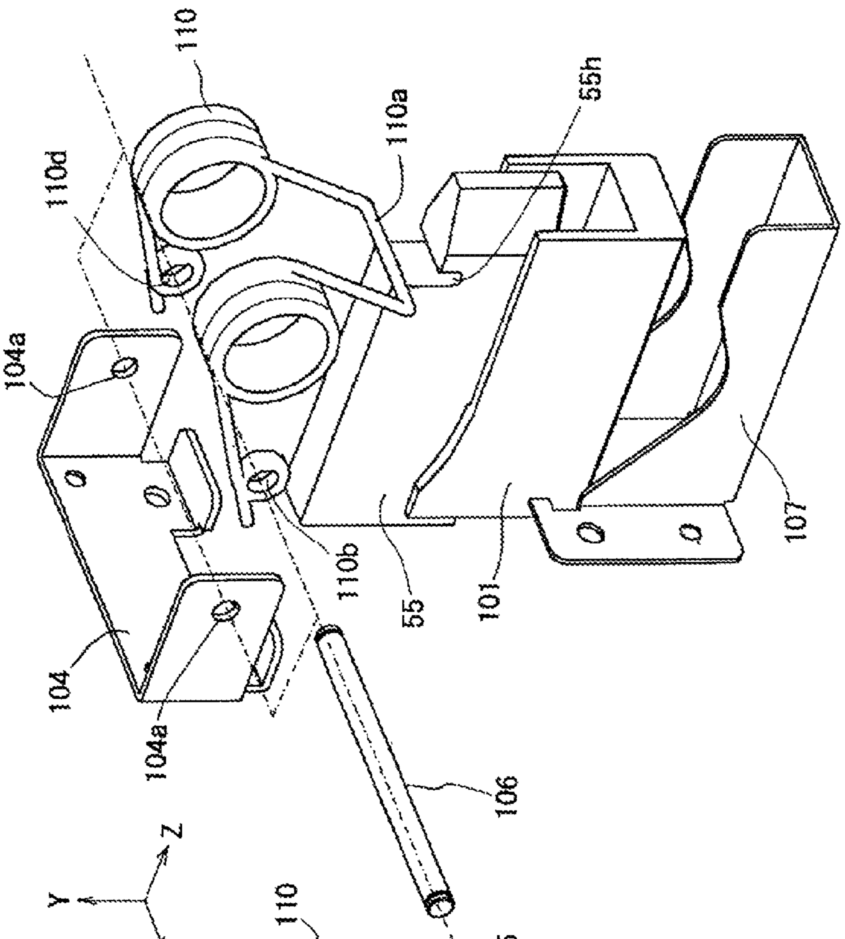


Fig. 3A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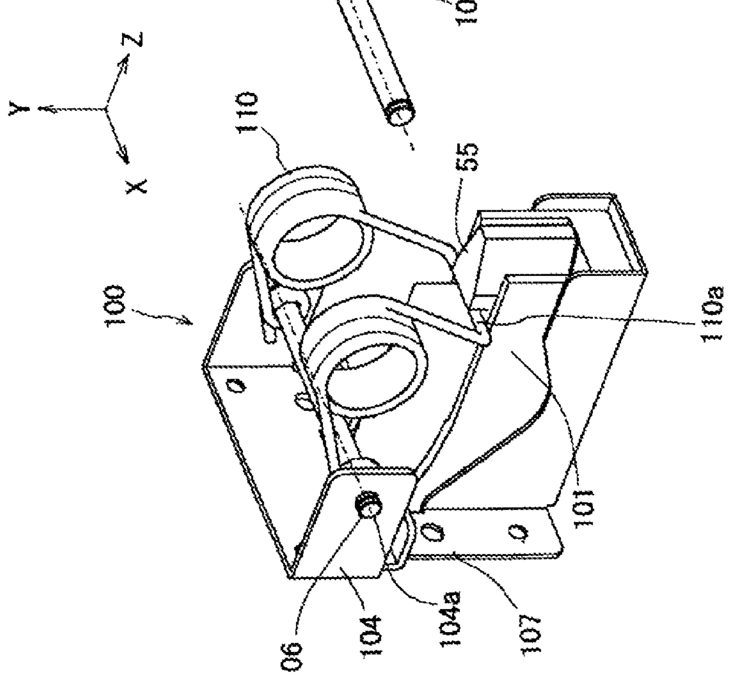
110b
55
101
107
Fig. 4B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106
Fig. 4A

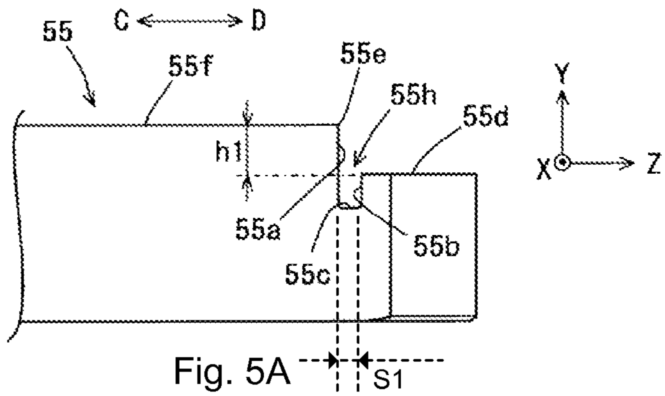


Fig. 5A

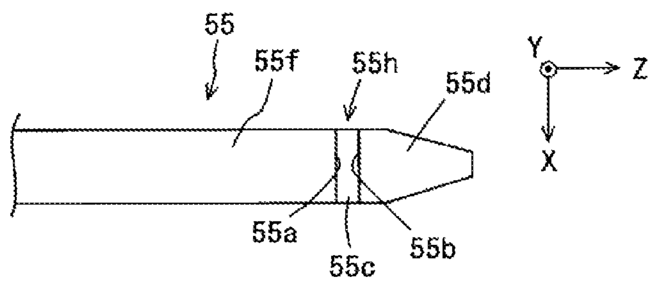


Fig. 5B

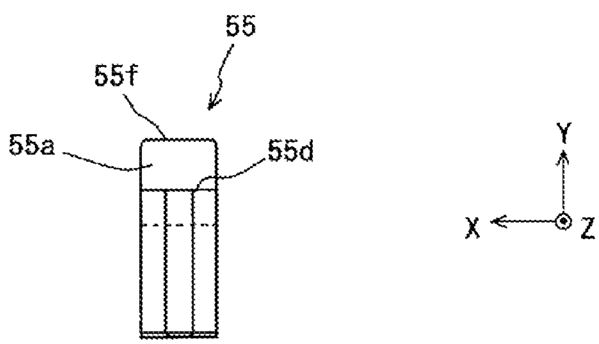
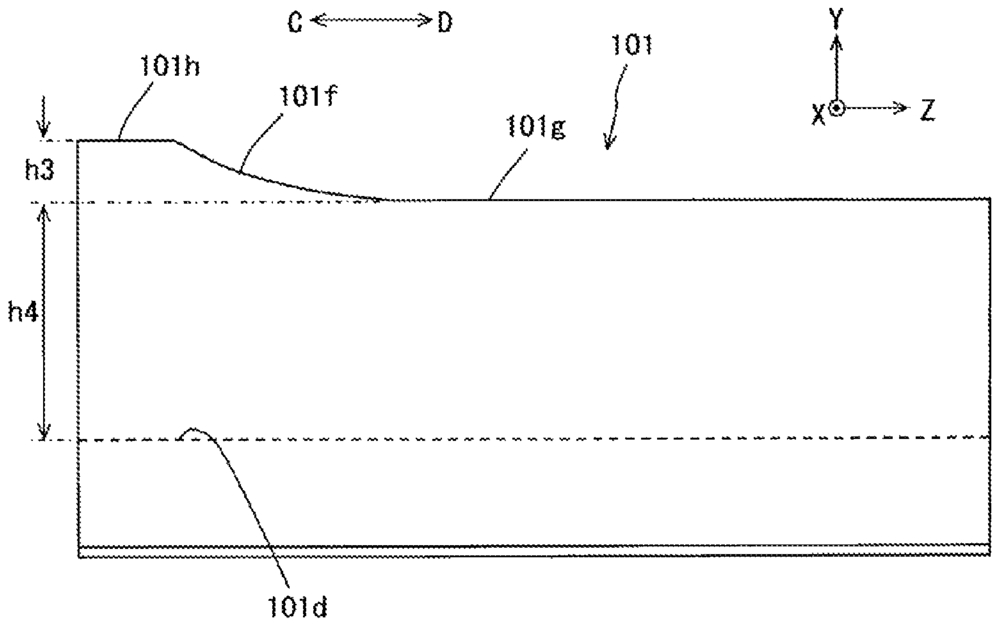


Fig. 5C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D
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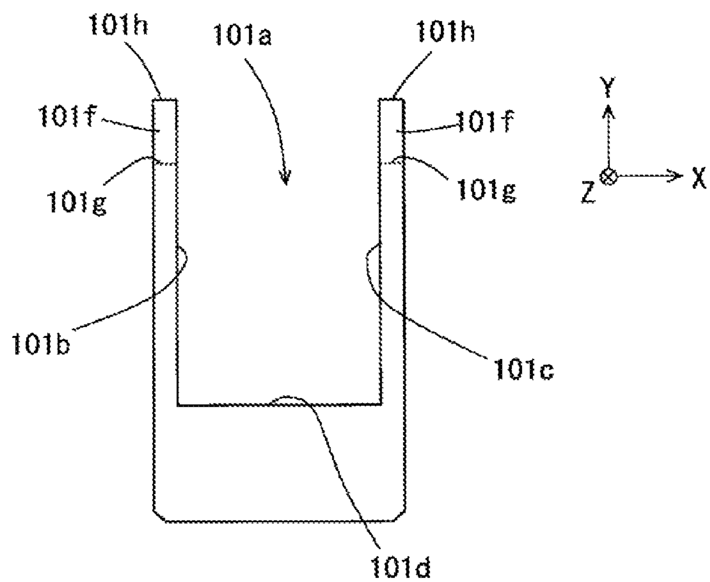
X
Z
101h
101f
101g
h3
h4
101d

Fig. 6A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101g
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X
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101c
101d

Fig. 6B

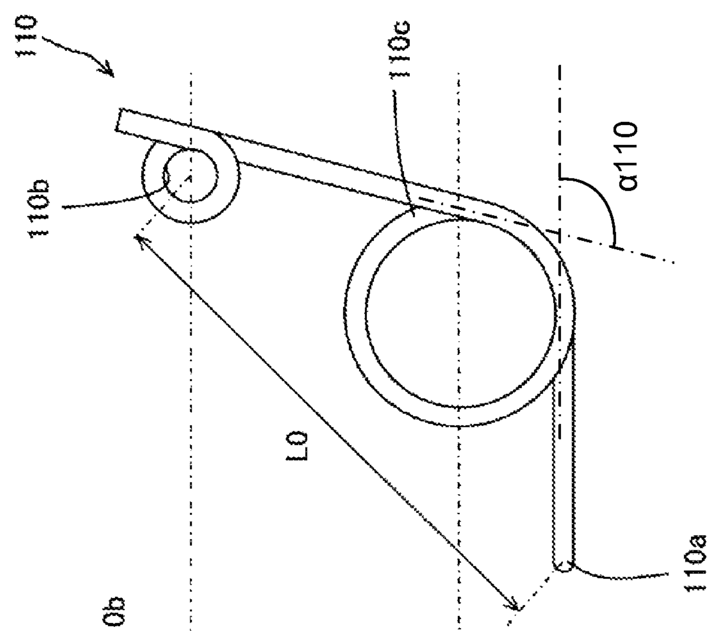


Fig. 7A

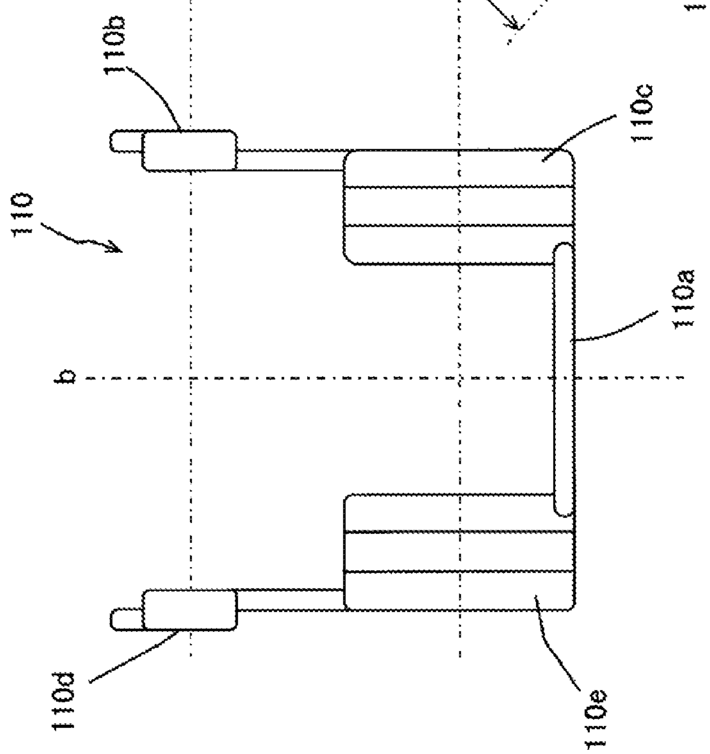
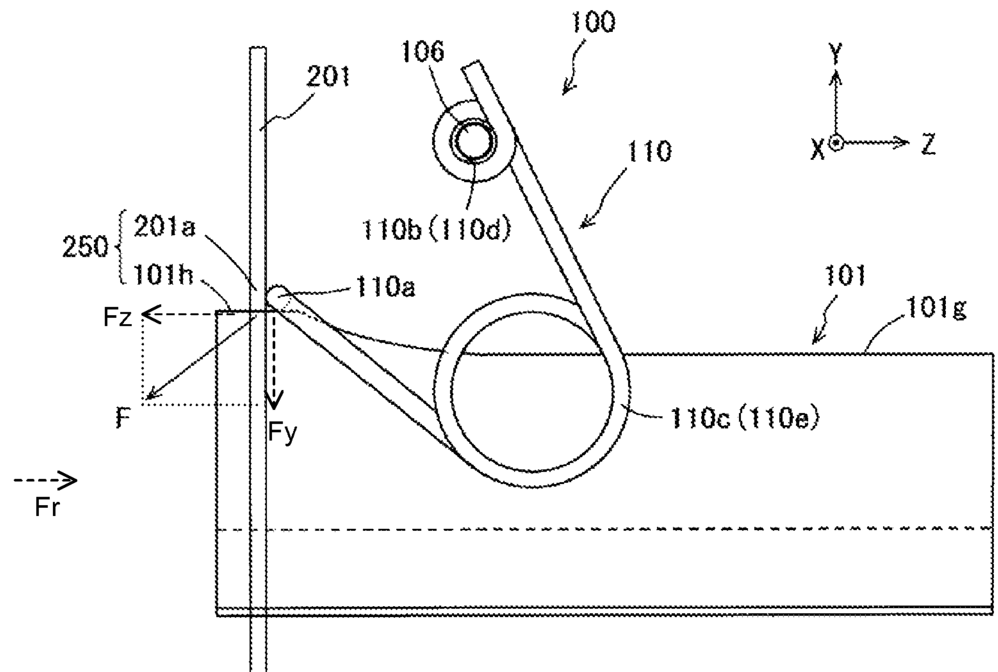


Fig. 7B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110
Y
X
Z
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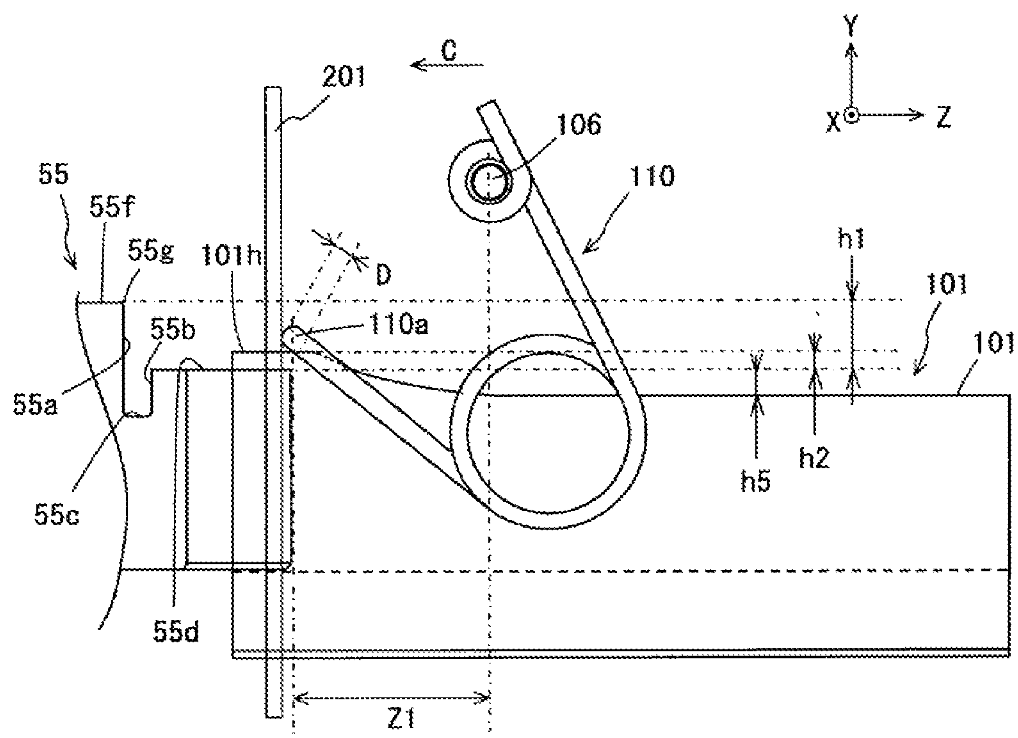
101h
110b (110d)
110a
101
101g
Fz
F
Fy
110c (110e)
Fr

Fig. 8A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201
Y
X
Z
106
55
55f
110
55g
101h
D
h1
101
55b
110a
101g
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h2
h5
55c
55d
Z1

Fig. 8B

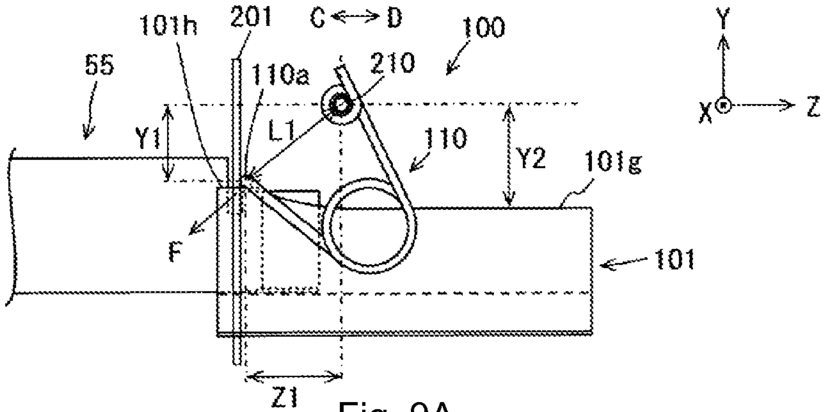


Fig. 9A

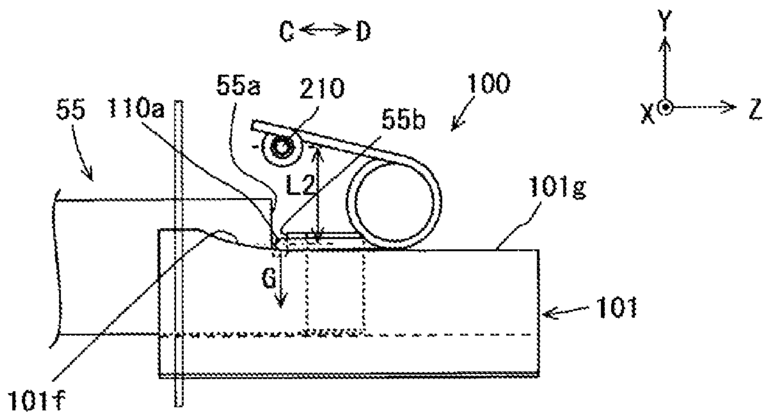


Fig. 9B

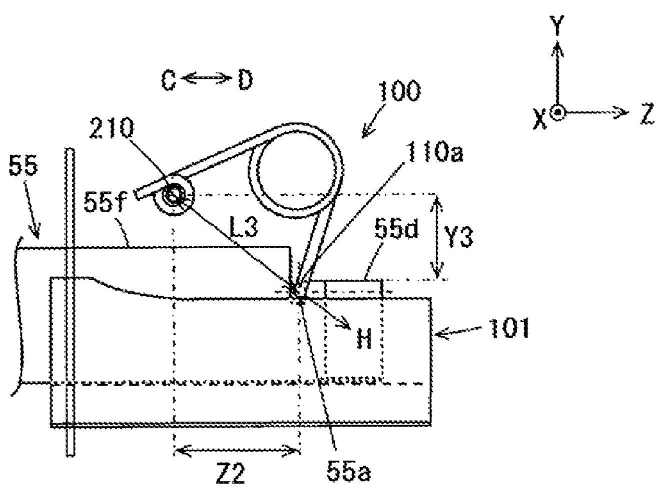


Fig. 9C

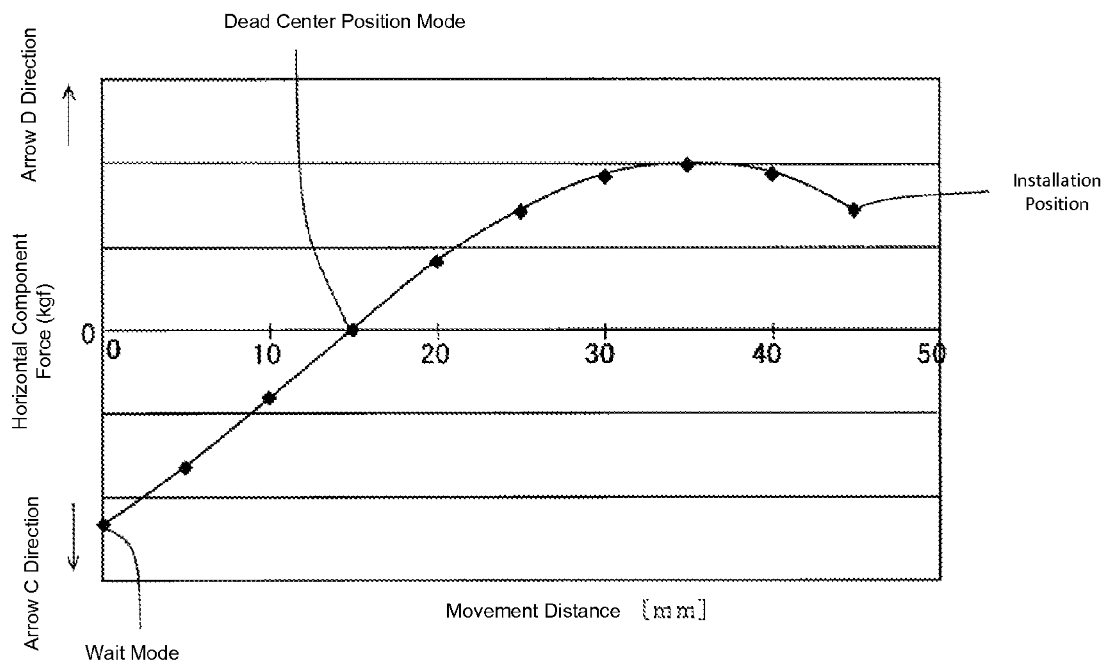

Dead Center Position Mode
Arrow D Direction
Horizontal Component Force (kgf)
Arrow C Direction
0
0
10
20
30
40
50
Installation Position
Movement Distance [mm]
Wait Mode

Fig. 10

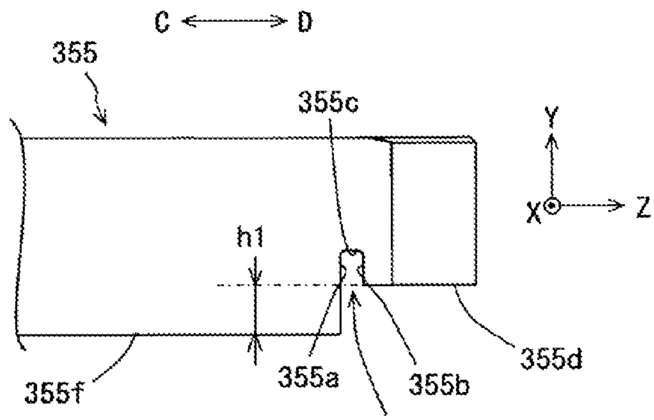


Fig. 11A

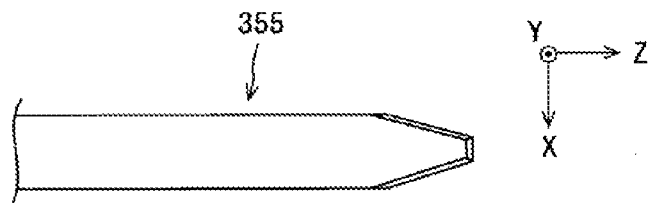


Fig. 11B

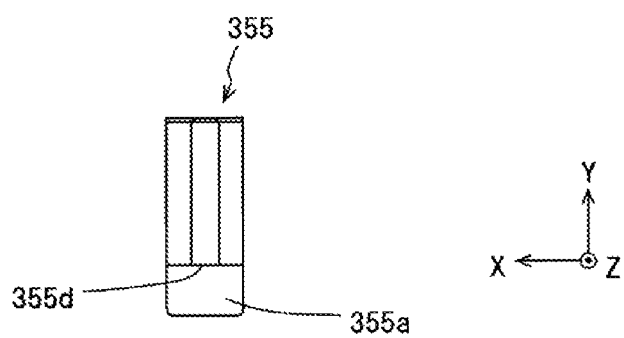


Fig. 11C

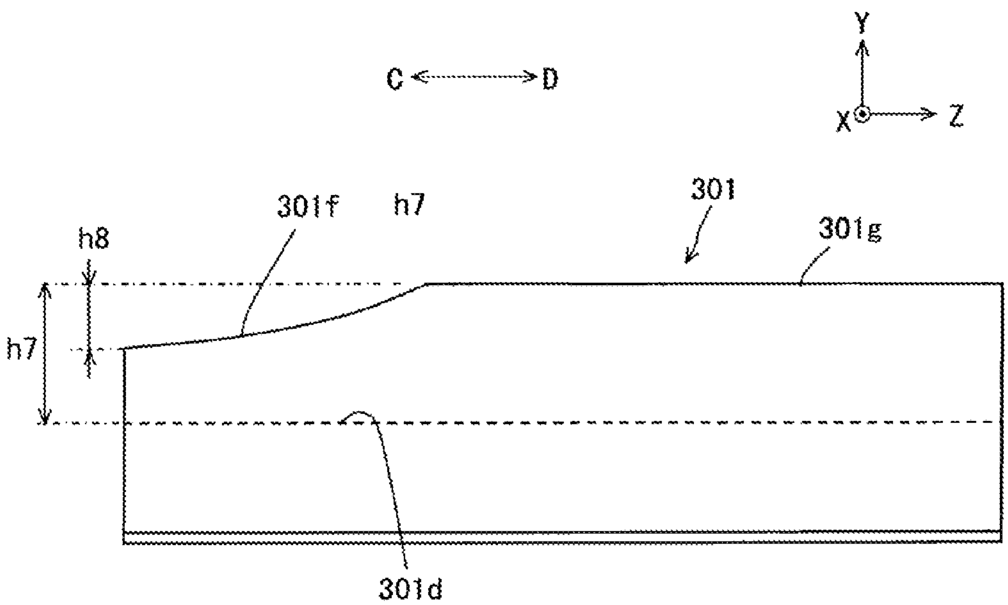


Fig. 12A

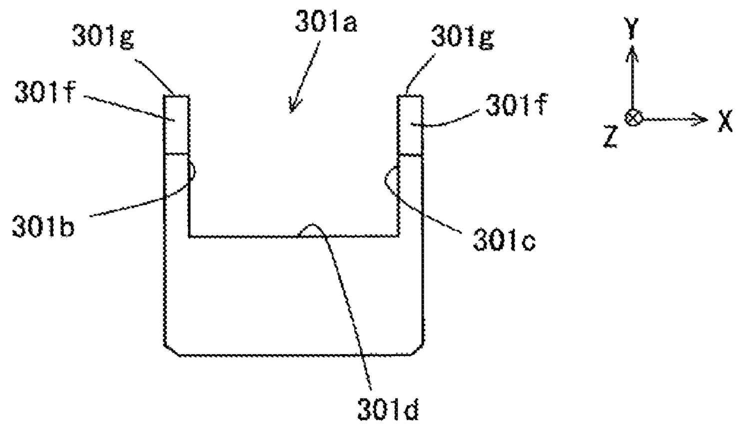


Fig. 12B

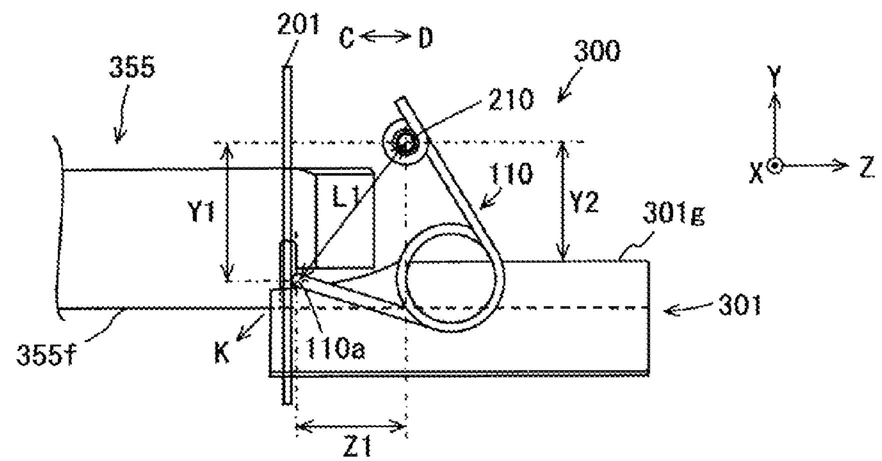


Fig. 13A

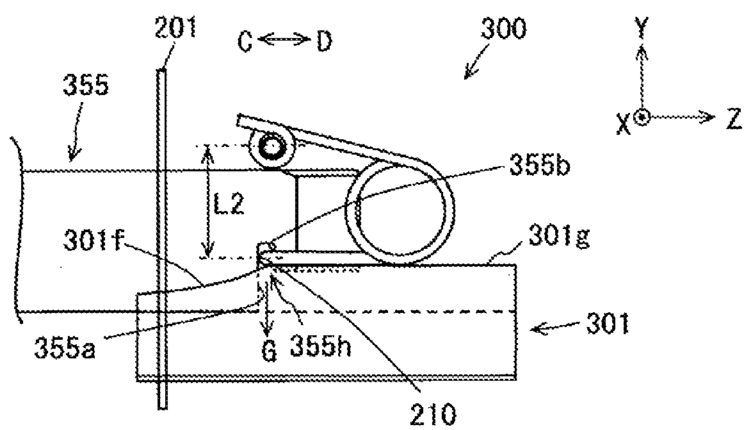


Fig. 13B

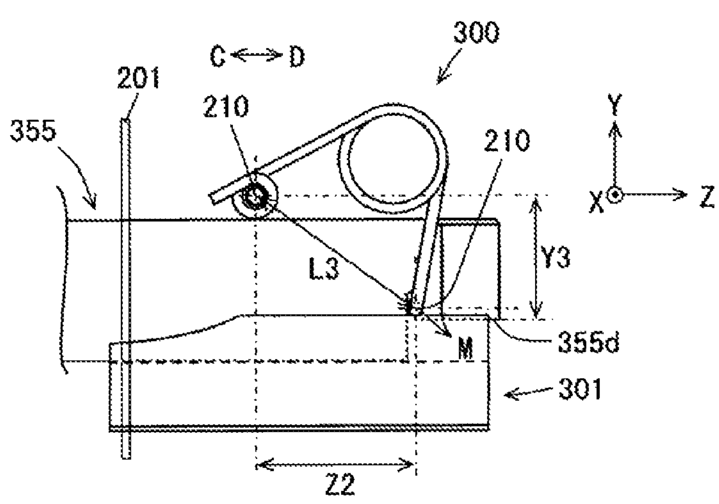


Fig. 13C

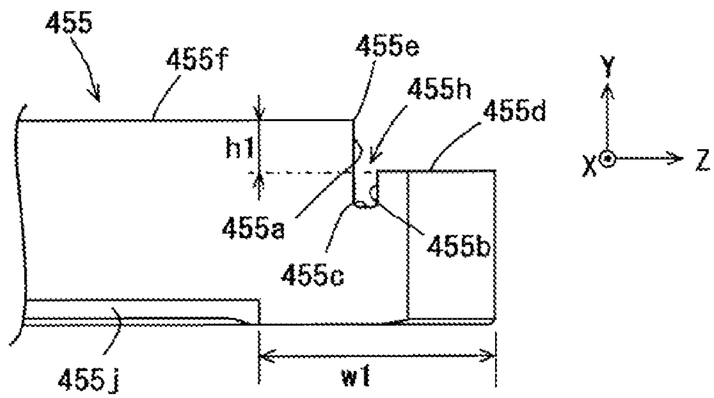


Fig. 14A

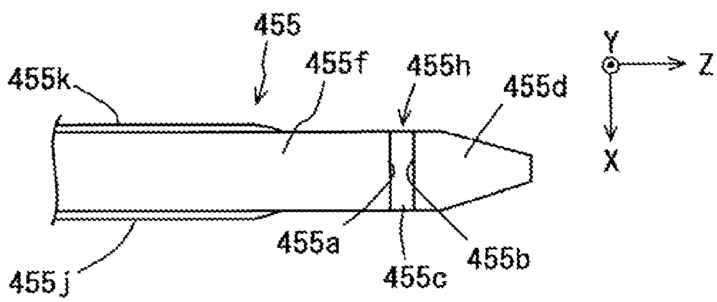


Fig. 14B

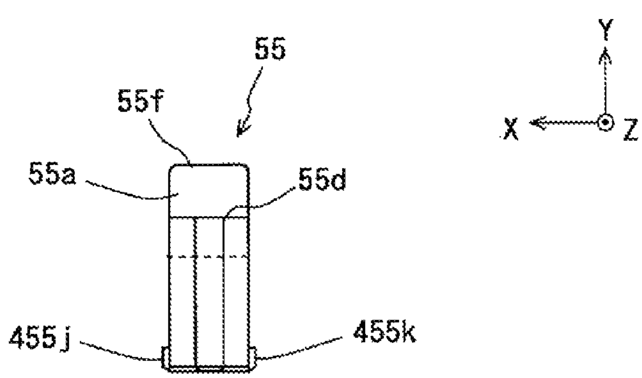


Fig. 14C

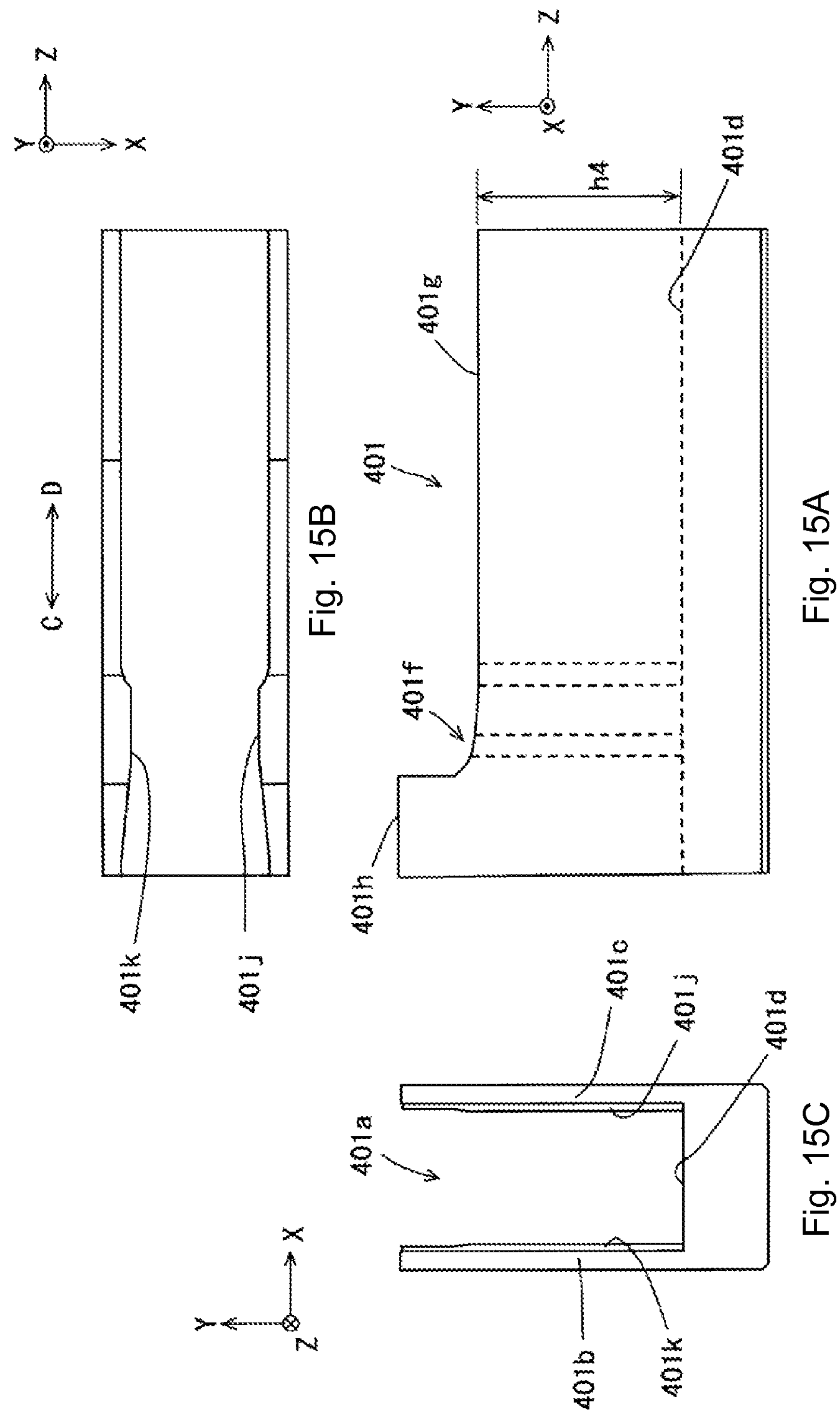


Fig. 15B

Fig. 15A

Fig. 15C

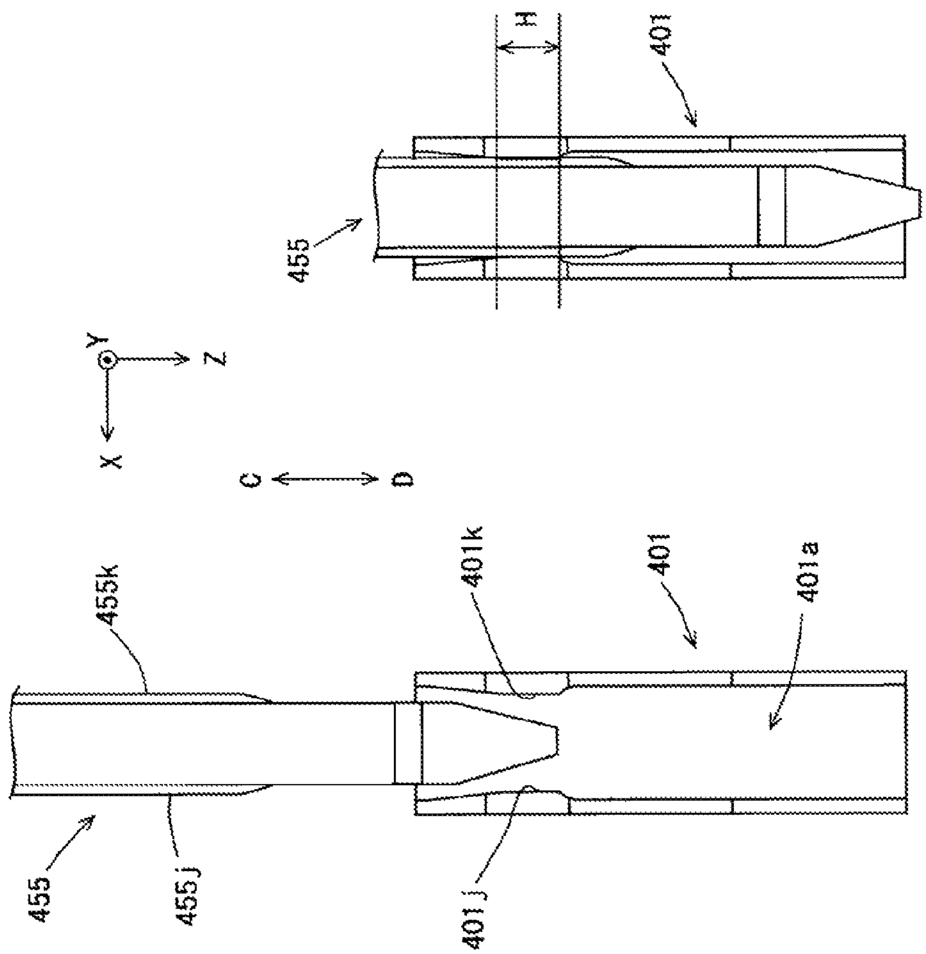


Fig. 16B

Fig. 16A

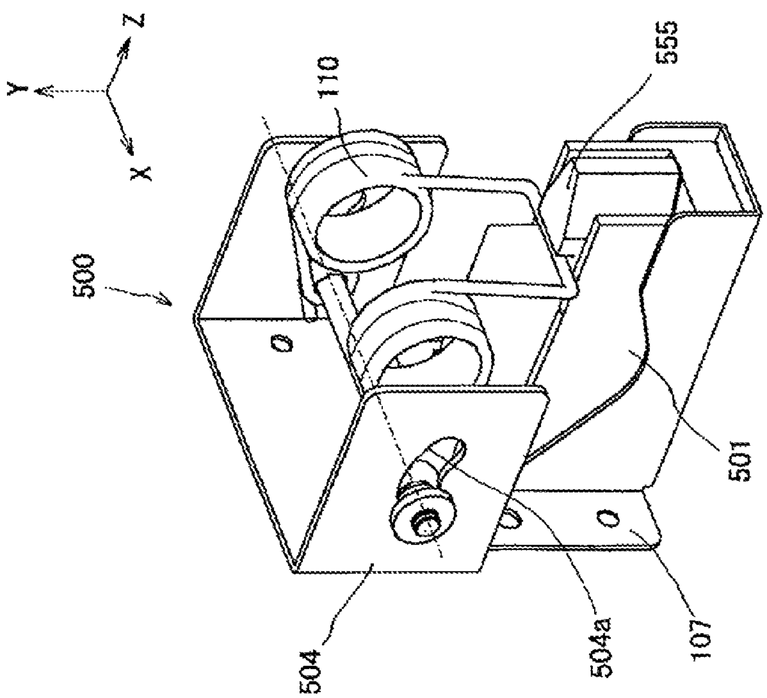
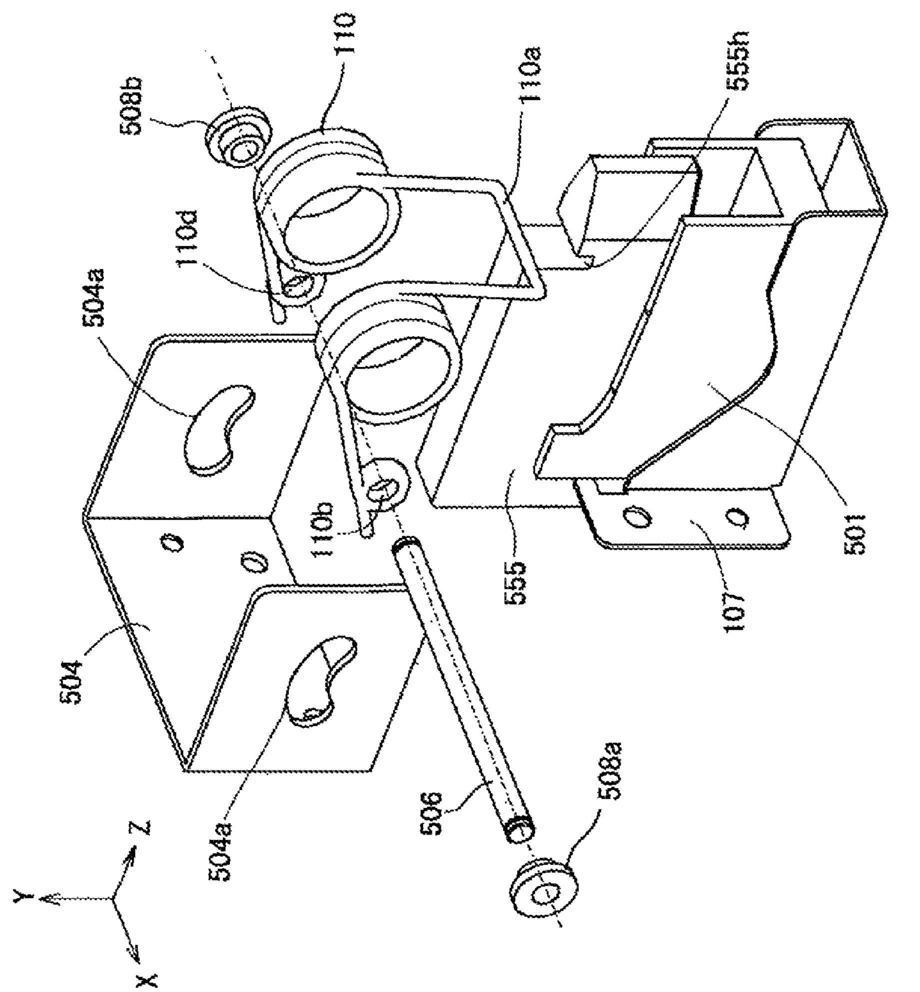


Fig. 17A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504a
X
Y
Z

Fig. 17B

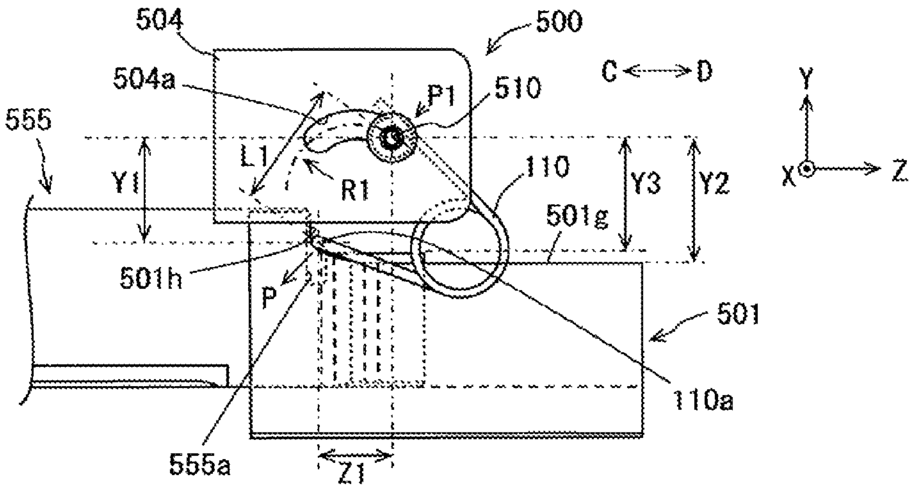


Fig. 18A

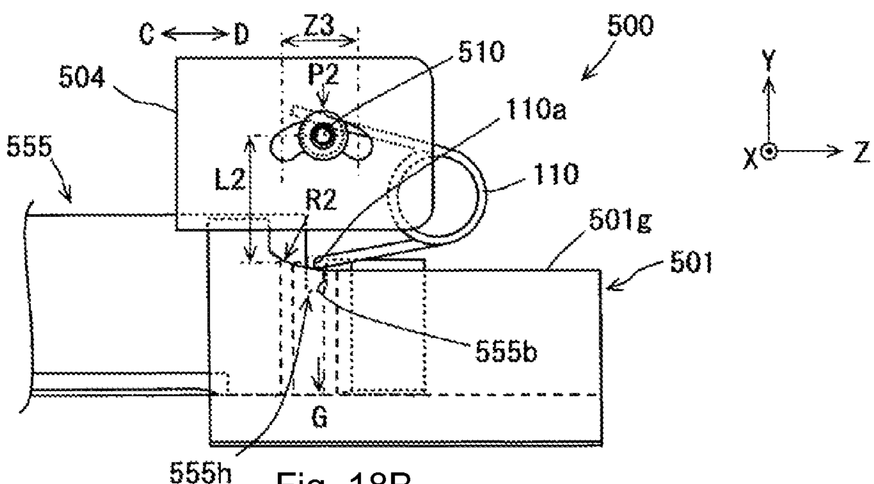


Fig. 18B

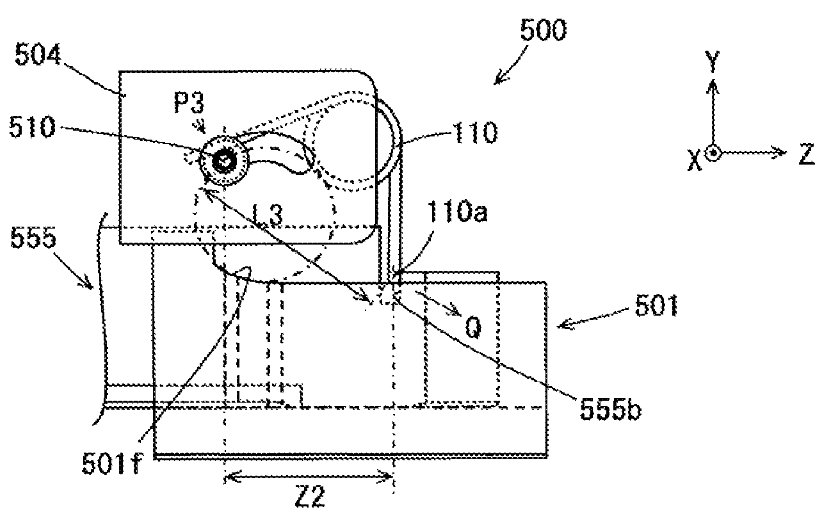
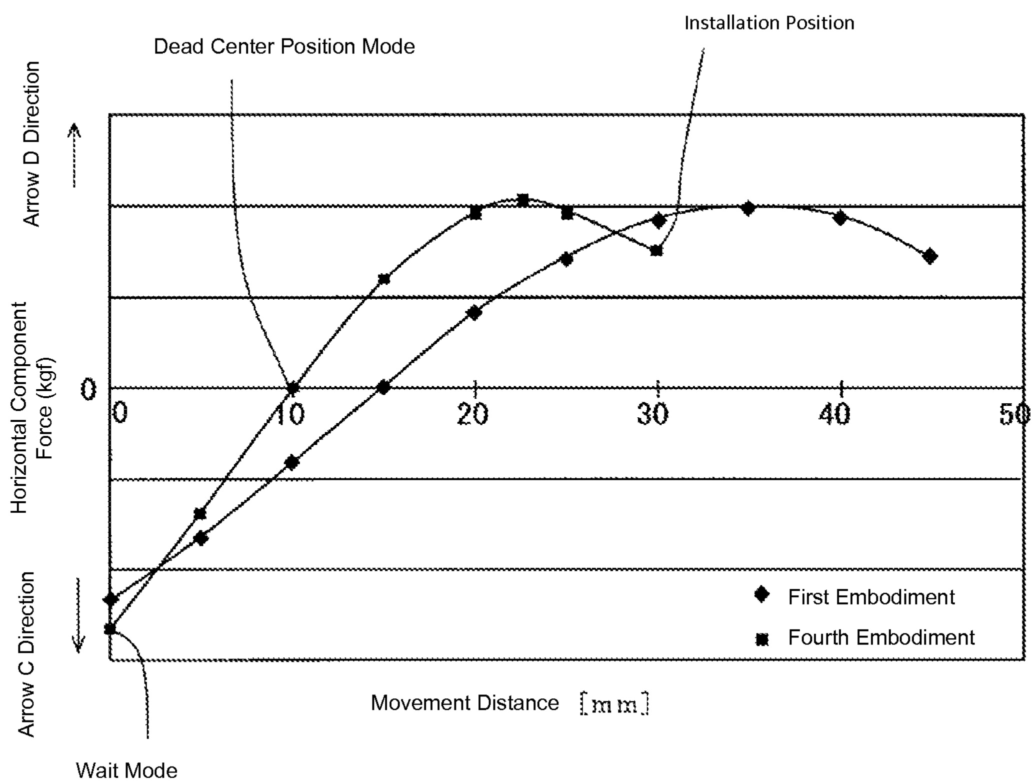


Fig. 18C



Installation Position
Dead Center Position Mode
Arrow D Direction
Horizontal Component Force (kgf)
Arrow C Direction
0
0
10
20
30
40
50
First Embodiment
Fourth Embodiment
Movement Distance [mm]
Wait Mode

Fig. 19

IMAGE FORMING APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

The present application is related to, claims priority from and incorporates by reference Japanese Patent Application No. 2012-100717, filed on Apr. 26, 2012.

TECHNICAL FIELD

The present invention relates to an image forming apparatus such as a photocopy machine, a printer and the like, especially to an image forming apparatus that includes a sheet supply cassette.

BACKGROUND

Conventionally, when a sheet supply cassette is installed to an image forming apparatus main body in such a image forming apparatus, a user pushes the sheet supply cassette in the apparatus to install the sheet supply cassette at a predetermined position in the image forming apparatus main body (e.g. see JP Laid-Open Patent Application No. 2003-276868, page 4, FIG. 6).

However, when the sheet supply cassette is installed to the image forming apparatus described above, force of the user to push the sheet supply cassette is insufficient and the user cannot install the sheet supply cassette securely.

SUMMARY

An image forming apparatus disclosed in the present application, in which a sheet supply cassette configured to stack recording media thereon slidably moves in an installation direction and a pull-out direction so that the sheet supply cassettes changes its position between a pull-out position where the sheet supply cassette is pulled out from an apparatus main body and an installation position where the sheet supply cassette is installed to the apparatus main body, includes: an engagement member provided on the sheet supply cassette; a biasing member that is configured with a first part, a second part and an elastic part formed of an elastic material, the first and second parts being linked with the elastic part, the second part being supported to the apparatus main body with a swing shaft such that the second part swings around the swing shaft, the first part engaging with the engagement member so that the biasing member maintains a compressed state by the engagement member; and a guide restriction member provided on the apparatus main body and configured to restrict a movement of the first part in the installation direction and the pull-out direction.

According to the present invention, when the sheet supply cassette is installed to the installation position, the sheet supply cassette is always stabilized in the installation position regardless the force of the user to push the sheet supply cassette.

BRIEF DESCRIPTION OF THE DRAWINGS

In the attached drawings:

FIG. **1** is a schematic diagram of a main configuration of an image forming apparatus according to a first embodiment of the present invention;

FIG. **2** is an operation explanatory diagram of the image forming apparatus according to the first embodiment seen from right side (X axis plus side);

FIG. **3**A is a plain view of a configuration of a sheet supply cassette according to the first embodiment;

FIG. **3**B is a perspective view of the configuration of the sheet supply cassette according to the first embodiment;

FIG. **4**A is a perspective view of configurations of an engagement member and a pull-in part according to the first embodiment;

FIG. **4**B is an exploded perspective view of the configurations of the engagement member and the pull-in part according to the first embodiment;

FIG. **5**A is a front view of the configuration of the engagement member according to the first embodiment;

FIG. **5**B is a plain view of the configuration of the engagement member according to the first embodiment;

FIG. **5**C is a side elevation view of the configuration of the engagement member according to the first embodiment from right side;

FIG. **6**A is a front view of a configuration of a guide member according to the first embodiment;

FIG. **6**B is a side elevation view of the configuration of the guide member according to the first embodiment from left side;

FIG. **7**A is a front view of a configuration of a double torsion coil spring;

FIG. **7**B is a side elevation view of the configuration of the double torsion coil spring from left side;

FIG. **8**A illustrates a wait status of the pull-in part when the sheet supply cassette moves to a pull-out position illustrated by dotted lines in FIG. **2** in the first embodiment;

FIG. **8**B illustrates a status of the front edge part of the engagement member that starts to insert into a groove part of the guide member in the first embodiment;

FIG. **9**A to C are operation explanatory diagrams of an operation status of the pull-in part when the sheet supply cassette moves from the pull-out position illustrated by the dotted lines in FIG. **2** to an installation position illustrated by solid lines in FIG. **2** in the first embodiment. FIG. **9**A shows the wait status, FIG. **9**B shows a dead center position status, and FIG. **9**C shown an installation status.

FIG. **10** is a graph illustrating a force generated by the double torsion coil spring in the arrow C and D directions (Z axis direction) is calculated according to the position of the engagement part of the double torsion coil spring in the Z axis direction in the first embodiment;

FIG. **11**A is a front view of a configuration of an engagement member according to a second embodiment based on the present invention;

FIG. **11**B is a plain view of the configuration of the engagement member according to the second embodiment; FIG. **11**C is a side elevation view of the configuration of the engagement member according to the second embodiment based on the present invention from right side;

FIG. **12**A is a front view of a configuration of a guide member according to the second embodiment;

FIG. **12**B is a side elevation view of the configuration of the guide member according to the second embodiment from left side;

FIG. **13**A to C are operation explanatory diagrams of an operation status of a pull-in part in a wait status, a dead center position status and an installation status when the sheet supply cassette moves from the pull-out position illustrated by the dotted lines in FIG. **2** to the installation position illustrated by the solid lines in FIG. **2** in the second embodiment, respectively;

FIG. **14**A is a front view of a configuration of an engagement member according to a third embodiment based on the present invention;

FIG. **14**B is a plain view of the configuration of the engagement member according to the third embodiment based on the present invention;

FIG. **14**C is a side elevation view of the configuration of the engagement member according to the third embodiment based on the present invention from right side;

FIG. **15**A is a front view of a configuration of a guide member according to the third embodiment;

FIG. **15**B is a plain view of the configuration of the guide member according to the third embodiment;

FIG. **15**C is a side elevation view of the configuration of the guide member according to the third embodiment from left side;

FIG. **16**A is an operation explanatory diagram of operations of the engagement member with respect to the guide member according to the third embodiment;

FIG. **16**B is an operation explanatory diagram of operations of the guide member and the engagement member according to the third embodiment;

FIG. **17**A is a perspective view of configurations of an engagement member and a pull-in part according to a fourth embodiment;

FIG. **17**B is an exploded perspective view of the configurations of the engagement member and the pull-in part according to the fourth embodiment;

FIG. **18**A to C are operation explanatory diagrams of an operation status of the pull-in part in a wait status, a dead center position status and an installation status when the sheet supply cassette moves from the pull-out position illustrated by the dotted lines in FIG. **2** to the installation position illustrated by the solid lines in FIG. **2** in the fourth embodiment, respectively; and

FIG. **19** is a graph illustrating a force generated by the double torsion coil spring in the arrow C and D directions (Z axis direction), the force calculated according to the position of the engagement part of the double torsion coil spring in the Z axis direction in the fourth embodiment.

DESCRIPTION OF EMBODIMENTS

First Embodiment

FIG. **1** is a schematic diagram of a main configuration of an image forming apparatus according to a first embodiment of the present invention.

In FIG. **1**, the sheet supply cassette **50** accommodates recording sheets **51** as recording mediums staked therein. The sheet supply cassette **50** is slidably held between an installation position and a pull-out position that are illustrated in FIG. **2** in an image forming apparatus **1** main body by holders **31***a* and **31***b* as discussed later. A main body in which movable configuration elements as the sheet supply cassette **50** of the image forming apparatus **1** are removed may be referred to as the image forming apparatus **1** main body. An installation status of the sheet supply cassette **50** in which the sheet supply cassette **50** is in an installation position as illustrated in FIG. **1** and other statuses than the installation status may merely be referred to as installation and removal.

A sheet stacking plate **54** is provided in the sheet supply cassette **50**. The sheet stacking plate **54** is swingably supported by a support shaft **53**. The recording sheets **51** stacks on the sheet stacking plate **54**. A lift-up lever **33** is rotatably linked to a support shaft **32** on a sheet feeding side of the sheet supply cassette **50**. The support shaft **32** is engaged with a motor **60** to contact and separate from the motor **60** in response to the installation and removal of the sheet supply cassette **50**. The motor **60** is controlled to rotate by a controller (not illustrated). Rotation of the motor **60** is transmitted to the support shaft **32** when the sheet supply cassette **50** is installed.

When the lift-up lever **33** rotates, a front edge part of the lift-up lever **33** lifts a bottom part of the sheet stacking plate **54**. Thereby, the recording sheets **51** that stack on the sheet stacking plate **54** are raised. A raise detection part **73** detects the recording sheets **51** that are raised to a certain height and abut on the pickup roller **62**. A controller (not illustrated) stops the rotation of the motor **60** based on information that the raise detection part **73** detects. A pickup roller **62**, a feed roller **63** and a retard roller **64** configures a sheet feeding part **61**. The feed roller **63** and the retard roller **64** are in a contact with and arranged to face each other.

The pickup roller **62** and the feed roller **63** are driven to rotate in arrow directions by a motor (not illustrated), and the feed roller **63** includes a one-way clutch mechanism (not illustrated) therein. Thus, the pickup roller **62** and the feed roller **63** idle in the arrow directions even when the motor stops rotating the pickup roller **62** and the feed roller **63**. Moreover, the retard roller **64** generates torque in the arrow direction by a torque generation device (not illustrated). The arrow direction is different from a direction in which the retard roller **64** is driven and rotated by the feed roller **63**. Accordingly, the pickup roller **62** picks up the recording sheet **51** that abuts on the pickup roller **62** from the inside of the sheet supply cassette **50**. The feed roller **63** and the retard roller **64** feed each of the recording sheets **51** to a carrying path in order even if the plurality of sheets **51** are simultaneously picked up, for example.

A sheet sensor **74**, a pair of carrying rollers **65**, a sheet sensor **75**, pairs of carrying rollers **66** and **67** and a writing sensor **76** are sequentially arranged on the downstream side of the sheet feeding part **61** in the arrow A direction. The arrow A indicates a carrying direction of the recording sheet **51**. The pair of carrying rollers **65** correct skew of the recording sheet **51**. The sheet sensor **75** detects the timing for driving the pair of carrying rollers **66** next to the sheet sensor **75**. The pairs of carrying rollers **66** and **67** send the recording sheet **51** to a secondary transfer part **79**. The writing sensor **76** detects the timing for writing in the image forming part **10**. Power is transmitted to the pairs of carrying rollers **65**, **66** and **67** from a carrying driving motor (not illustrated) via driving transmission parts such as gears and the like (not illustrated).

A multipurpose tray (MPT) **80** is provided on the right side surface of the image forming apparatus **1** in FIG. **1**. The MPT **80** feeds recording sheets **81** stacked on the sheet stacking plate **82**. The MPT **80** includes a sheet stacking plate **82**, a pickup roller **83**, a sheet supply roller **84**, and a retard roller **85** and the like. The sheet stacking plate **82** stacks the recording sheets **81**. The pickup roller **83** contacts and feeds the recording sheet **81**. The sheet supply roller **84** sends the fed sheet **81** to the carrying path of the image forming apparatus **1** main body. The retard roller **85** is biased by and abuts on the sheet supply roller **84** to separate the sheets one by one.

The image forming part **10** includes four process units **11**Y, **11**M, **11**C and **11**K (may merely be referred to as a process unit **11** if not necessary to be especially distinguished). The process units **11**Y, **11**M, **11**C and **11**K form yellow (Y), magenta (M), cyan (C) and black (K) toner images (developer images), respectively. The process units **40**Y, **40**M, **40**C, **40**K are arranged sequentially from the upstream side of a later-discussed intermediate transfer belt **44** of an intermediate transfer belt unit **40** in the arrow B direction. The arrow B indicates a movement direction in which the intermediate transfer belt **44** moves above the intermediate transfer belt unit **40**.

Internal configurations of the process units **11** are same. Therefore, an internal configuration of the black process unit **11**K is explained as an example.

The photosensitive drum **21** is arranged in the process unit **11**K to rotate in an arrow direction. A charge roller **22** and an exposure device **12** are arranged on the circumference of the photosensitive drum **21** sequentially from the upstream side of the rotation direction of the photosensitive drum **21**. The charge roller **22** supplies electric charges on and charges the surface of the photosensitive drum **21**. The exposure device **12** selectively irradiates the surface of the charged photosensitive drum **21** with light to form an electrostatic latent image on the surface of the photosensitive drum **21**.

Moreover, a development roller **23** and a drum cleaning part **24** are arranged on the surface of the photosensitive drum **21** on which the electrostatic latent image has been formed. The development roller **23** attaches black toner to the electrostatic latent image to develop the electrostatic latent image. The cleaning part **24** removes transfer residual toner that remains on the photosensitive drum **21** after a toner image on the photosensitive drum **21** has been transferred. A toner containing part **25**K contains toner and provides the toner on the development roller **23**. Power is transmitted to the drum and the roller used in each of the process units from a driving source (not illustrated) via gears and the like (not illustrated). Thereby, the drum and the roller rotate.

The intermediate transfer belt unit **40** includes a driving roller **41**, a tension roller **43**, a secondary transfer backup roller **42** and the intermediate transfer belt **44**. The driving roller **41** is driven by a driving part (not illustrated). The tension roller **43** gives tension to the intermediate transfer belt **44** with a biasing part such as a coil spring. The secondary transfer backup roller **42** is arranged to face a secondary transfer roller **46**, and configures a secondary transfer part **79**. The intermediate transfer belt **44** is strained by the rollers. Moreover, the intermediate transfer belt unit **40** is arranged to face a belt cleaning part **47** and the photosensitive drum **21** of each process unit **11**. The belt cleaning part **47** removes toner that remains on the intermediate transfer belt **44**. Furthermore, the intermediate transfer belt unit **40** includes four primary transfer rollers **45** and the like. A predetermined voltage is applied to the primary transfer rollers **45** so that the primary transfer rollers **45** transfer the toner images in the respective colors, which have been formed on the respective photosensitive drums **21**, sequentially over each other on the intermediate transfer belt **44**.

The intermediate transfer belt unit **40** transfers the above-discussed toner image, which has been formed by the image forming part **10**, onto the intermediate transfer belt **44**. Furthermore, the intermediate transfer belt unit **40** transfers the toner image onto the recording sheet **51** fed from the sheet supply cassette **50** or the recording sheet **81** fed from the MPT **80** at the secondary transfer part **79**.

A fuser part **90** includes a pair of an upper roller **91** and a lower roller **92**. The upper roller **91** includes a halogen lamp (heat source) **93** therein, and includes a surface formed of an elastic member. The lower roller **92** includes a halogen lamp (heat source) **94** therein, and includes a surface formed of an elastic member in the same manner as the upper roller **91**. The fuser part **90** applies heat and pressure to the toner image on the recording sheet **51** (or **81**) sent by the secondary transfer part **79**, and fuses the toner image to fix the toner image on the recording sheet **51** (or **81**).

After that, the recording sheet **51** (**81**) is carried and ejected on a stacker part **78** by pairs of ejection rollers **68**, **69**, **70** and **71**. Power is transmitted to the pairs of ejection rollers from a driving source (not illustrated) via driving transmission parts (not illustrated). A sheet sensor **77** is arranged at an output part of the fuser part **90**. The sheet sensor **77** detects the timing for driving the pairs of ejection rollers **68**, **69**, **70** and **71**.

Each of the axes X, Y and Z in FIG. **1** extend as follows: the X axis extends in a carrying direction (the arrow B direction) in which the intermediate transfer belt **44** passes the process units **11**; the Z axis extends in a rotational axial direction around which the photosensitive drum **21** rotates; and the Y axis extends in a direction orthogonal to both of the axes described above. When the axes X, Y, and Z are illustrated in later-discussed other drawings, the directions of the axes illustrate the same directions. Namely, the X, Y, and Z axes in the drawings illustrate directions in which parts depicted in the drawings are arranged when the parts configure the image forming apparatus **1** illustrated in FIG. **1**. The parts are arranged so that the Y axis extends in a substantially vertical direction.

FIG. **2** illustrates an operation explanatory diagram of the image forming apparatus **1** according to the present embodiment seen from right side (X axis plus side).

As illustrated in FIG. **2**, the sheet supply cassette **50** is held between the pull-out position and the installation position by the holders **31***a* and **31***b* described above (FIG. **1**) so that the sheet supply cassette **50** slides in the arrow C direction (pull-out direction) and D direction (installation direction) along the Z axis. The pull-out position is in the lower part of the image forming apparatus **1** main body. The recording sheets **51** are refilled in the sheet supply cassette **50** when the sheet supply cassette **50** is at the pull-out position (illustrated by dotted lines in FIG. **2**). The installation position (illustrated by solid lines in FIG. **2**) is a position in which the recording sheets **51** are carried from the sheet supply cassette **50** by the sheet feeding part **61** when the sheet supply cassette **50** is installed to the image forming apparatus **1**. The sheet supply cassette **50** includes a cassette cover **52**. A front surface of the cassette cover **52** faces a user, and the cassette cover **52** is fixed to the sheet supply cassette main body. The user grabs the cassette cover **52**, slides and moves the sheet supply cassette **50**.

A fixing member **201** is arranged on the downstream side of the installation direction (arrow D direction) of the sheet supply cassette **50**. The fixing member **201** is fixed to the image forming apparatus **1** main body. The fixing member **201** is provided with a pull-in part **100**. As discussed later, the pull-in part **100** guides and bias in the installation direction (arrow D direction) an engagement member **55** when the sheet supply cassette **50** moves in the installation direction. The engagement member **55** extends from a rear edge part of the sheet supply cassette **50**. As shown in FIG. **2**, the engagement member **55** is positioned at a downstream end part in the installation direction (D) of the sheet supply cassette.

FIG. **3**A is a plain view of a configuration of the sheet supply cassette **50** according to the present embodiment. FIG. **3**B is a perspective view of the configuration of the sheet supply cassette **50** according to the present embodiment.

The cassette cover **52** that the user grips includes an installation positioning surface **58**. The installation positioning surface **58** abuts on an abutment part **202** fixed on the image forming apparatus **1** main body. Thereby, the sheet supply cassette **50** is positioned at the installation position in the installation direction (arrow D direction along the Z axis). A cassette cover post **56** is inserted into an engagement hole **202***a* of the abutment part **202**, and a cassette post **57** is inserted into an engagement hole (not illustrated) formed at a position that corresponds to the fixing member **201** (FIG. **2**) fixed to the image forming apparatus **1** main body. Thereby, the sheet supply cassette **50** is positioned at the installation position in the X axis direction. The later-discussed engagement member **55** is formed on a rear surface of the sheet supply cassette **50** on the downstream of the installation direction to project from the rear surface toward the downstream side of the arrow D direction.

FIG. **4**A is a perspective view of configurations of the engagement member **55** and the pull-in part **100** according to the first embodiment. FIG. **4**B is an exploded perspective view of the configurations of the engagement member **55** and the pull-in part **100** according to the first embodiment.

In FIG. **4**, a swing support member **104** and a guide support member **107** formed in a C-shape are fixed to the fixing member **201** (see FIG. **2**) fixed to the image forming apparatus **1** main body. A spring shaft **106** is fixed to a pair of shaft holes **104***a* of the swing support member **104** that face each other. A later-discussed double torsion coil spring **110** as a biasing member is rotatably supported by the spring shaft **106**. A later-discussed guide member **101** is fixed to the guide support member **107**. As discussed later, the guide member **101** guides an engagement part **110***a* of the double torsion coil spring **110**. The engagement part **110***a* engages with the engagement member **55** of the sheet supply cassette **50**. The engagement member **55** moves in a groove part of the guide member **101**. Here, the fixing member **201**, the guide support member **107** and the guide member **101** correspond to guide restriction members.

FIG. **5**A is a front view of the configuration of the engagement member **55**. FIG. **5**B is a plain view of the configuration of the engagement member **55**. FIG. **5**C is a side elevation view of the configuration of the engagement member **55** from right side. As illustrated in FIG. **4**, the engagement member **55** is formed to protrude from the rear surface of the sheet supply cassette **50** on the downstream of the installation direction.

As illustrated FIGS. **5**A to C, the engagement member **55** is a substantially cuboid member that extends in the Z axis direction. A groove part **55***h* is formed in the upper side of the engagement member **55** in the vicinity of the front edge part thereof in a width direction (X axis direction). The groove part **55***h* is formed between an upper flat surface **55***f* and an upper flat surface **55***d*. The upper flat surface **55***f* is formed on the engagement member **55** on the arrow C side (sheet supply cassette **50** side). The upper flat surface **55***d* is formed on the engagement member **55** on the arrow D side (front edge side of the engagement member **55**). The upper flat surface **55***d* is a predetermined distance h**1** lower than the upper flat surface **55***f*. Wedge-shaped both sides of the engagement member **55** in the front edge side narrow along the front edge thereof. An engagement surface **55***a* (first surface) of the groove part **55***h* is a wall on the arrow C side. An engagement surface **55***b* (second surface) of the groove part **55***h* is a wall on the arrow D side. The engagement surfaces **55***a* and **55***b* face each other through a bottom part **55***c* therebetween, and are formed vertically to the Z axis. As discussed later, when the engagement member **55** moves, the engagement surfaces **55***a* and **55***b* engage with the engagement part **110***a* of the double torsion coil spring **110**. The engagement part **110***a* and the engagement surfaces **55***a* and **55***b* act on each other. More specifically, the engagement surface **55***a* (or a first surface) guides the engagement part **110***a* (or a first part) toward the groove part **55***h*. Herein, the groove **55***h* is formed with the engagement surface **55***a*, the engagement surface **55***b* that is disposed facing the engagement surface **55***a* with a predetermined space S**1**, and the engagement surface **55***c* that unites the engagement surface **55***a* to the engagement surface **55***b*. The engagement surface **55***a* is disposed at an upstream side in Z-direction. The engagement surface **55***b* is disposed at a downstream side in Z-direction. The space S**1** is greater than a diameter of the first part **110***a*. The engagement surfaces **55***a* and **55***b* extend in a direction (Y direction) that is substantially perpendicular to Z direction and X direction. Z direction means a direction along which the sheet supply cassette **50** moves. X direction means a direction along which the spring shaft **106** extends, the spring shaft **106** functioning as a swing shaft around which the bias member **110** swings. The "substantially perpendicular" means a range from plus and minus 10 degrees in Y direction.

FIG. **6**A is a front view of a configuration of the guide member **101**. FIG. **6**B is a side elevation view of the configuration of the guide member **101** from left side. As illustrated in FIG. **4**, the guide member **101** is fixed to and held by the guide support member **107**.

As illustrated in FIG. **6**B, the guide member **101** includes a cross-sectional surface formed in a C-shape. The left and right guide walls **101***b* and **101***c* as well as the bottom part **101***d* of the guide member **101** form a groove part **101***a*. The engagement member **55** that moves in the arrow D direction inserts into the groove part **101***a* when the sheet supply cassette **50** moves in the installation direction. The engagement member **55** moves on the bottom part **101***d* while the left and right guide walls **101***b* and **101***c* restricts the engagement member **55**.

The guide walls **101***b* and **101***c* are opposed to and symmetrically formed with respect to each other. The guide walls **101***b* and **101***c* include a first horizontal part **101***g*, a second horizontal part **101***h* and an incline part **101***f*, respectively. An upper surface of each first horizontal part **101***g* is formed at a h**4** height from the bottom part **101***d*, and extends from an edge part on the arrow D direction to a position in which the first horizontal part **101***g* exceed a center part. The second horizontal part **101***h* is formed near an edge part on the arrow C direction and at a height a distance h**3** higher than the first horizontal part **101***g*. The incline part **101***f* is formed between the first horizontal part **101***g* and the second horizontal part **101***h*. The incline part **101***f* includes a gentle incline surface that connects both of the horizontal parts **101***g* and **101***h*. Herein, the incline part **101***f* functions as a guiding part, the first horizontal part **101***g* as a first restrict part, the second horizontal part **101***h* as a second restrict part.

FIG. **7**A is a front view of a configuration of the double torsion coil spring **104**. FIG. **7**B is a side elevation view of the configuration of the double torsion coil spring **104** from left side. As illustrated FIG. **4**, the double torsion coil spring **110** is rotatably supported by the spring shaft **106** of the swing support member **104**.

The double torsion coil spring **110** is substantially symmetrically formed about a center line b. The double torsion coil spring **110** includes winding parts **110***c* and **110***e* formed on both sides thereof with the engagement part **110***a* (elastic part) therebetween. The engagement part **110***a* as a first part is formed in a crank shape at one end sides of the winding parts **110***c* and **110***e* as shown in FIG. **4**B. On the other hand, other end sides of the winding parts **110***c* and **110***e* respectively include shaft holes **110***b* and **110***d* as second parts formed in the vicinity of front edge parts of the winding parts **110***c* and **110***e*. The other end sides and the one end sides of the winding parts **110***c* and **110***e* are formed with an obtuse angle (α**110**) therebetween, respectively. At this time, a length between the engagement part **110***a* (more specifically, the leading edge of the part **110***a*) and a center of the shaft hole **110***b* (**110***d*) is L**0** when they are in a natural status (i.e., umcompressed status).

Next, operations of the pull-in part **100** and the engagement member **55** mounted in the image forming apparatus **1** are explained. The pull-in part **100** includes the guide member **101**, the double torsion coil spring **110** and members that support the guide member **101** and the double torsion coil spring **110**.

FIG. **8**A illustrates a wait status (first status) of the pull-in part **100** when the sheet supply cassette **50** moves to the pull-out position illustrated by the dotted lines in FIG. **2**. In the wait status, the double torsion coil spring **110** is rotatably supported by the spring shaft **106** that have inserted into the pair of shaft holes **110***b* and **110***d* while the engagement part **110***a* has been guided to the second horizontal part **101***h* of the guide member **101**, abuts on, is restricted the movement thereof, and is compressed by the fixing member **201**. Accordingly, in the wait status, the double torsion coil spring **110** waits in a state illustrated in the FIG. **8**A while the double torsion coil spring **110** generates a bias force in an arrow F direction. In details, the bias force F is resolved into one bias element Fz in Z direction and the other bias element Fy in Y direction. In a case where the bias element Fz is greater than a maximum static frictional force Fr that is created between the sheet supply cassette **50** and the apparatus main body, the cassette **50** is able to move only with the bias element Fz toward the pull-out direction (C direction) regardless of the static frictional force Fr. With this function, the cassette **50** is prevented to some degrees from stopping in a middle of a travel toward the pull-out position, providing a user friendly handling. A minimal requirement to achieve the function is that a maximum bias element Fz which is generated while the sheet supply cassette **50** moves from a dead center position to a first state (discussed later) is greater than a maximum static frictional force Fr. Only for ease of understanding, the direction of Fr is illustrated in FIG. **8**A.

Namely, the movement of the engagement part **110***a* of the double torsion coil spring **110** is restricted by a position restriction part **250** in the state. The position restriction part **250** is configured with the second horizontal part **101***h* of the guide member **101** and a contact part **201***a* of the fixing member **201**. As described below, the engagement part **110***a* is ready to engage with the groove part **55***h* (FIG. **5**A) of the engagement member **55** of the sheet supply cassette **50**. The engagement member **55** moves toward the installation position.

FIG. **8**B illustrates a status of the front edge part of the engagement member **55** that starts to insert into the groove part **101***a* (FIG. **6**B) of the guide member **101** when the sheet supply cassette **50** moves in the arrow D direction from the pull-out position illustrated by the dotted lines in FIG. **2**. As illustrated in FIG. **8**B, the second horizontal part **101***h* of the guide member **101** is an interval h**2** higher than the upper flat surface **55***d* of the engagement member **55** in a height direction (Y axis direction). Namely, the upper flat surface **55***d* is arranged to be more separated from the engagement part **110***a* in the wait status at h**2** in the height direction than the second horizontal part **101***h*.

The interval h**2** is arranged with respect to the difference h**1** between the upper flat surface **55***d* of the engagement member **55** and a highest part **55***g* (here, corresponds to the upper flat surface **55***f*) of the engagement surface **55***a* as follows:

$$h1>h2>0.$$

Namely, the second horizontal part **101***h* of the guide member **101** is positioned between the upper flat surface **55***d* and the highest part **55***g* in the height direction.

As illustrated in FIG. **8**B, in the wait status, the engagement part **110***a* of the double torsion coil spring **110** is arranged to abut on the engagement surface **55***a* of the engagement member **55** in a region Z**1** in the Z axis direction. The region Z**1** is closer to the arrow C side than the spring shaft **106** as a swing shaft of the double torsion coil spring **110**. The Z axis direction is a direction in which the sheet supply cassette **50** moves.

By configuring as described above, the engagement member **55** is guided in the pull-in part **100** when the sheet supply cassette **50** moves in the arrow D direction from the pull-out position illustrated by the dotted lines in FIG. **2**.

As illustrated in FIG. **8**B, the first horizontal part **101***g* of the guide member **101** is an interval h**5** higher than the upper flat surface **55***d* of the engagement member **55** in the height direction (Y axis direction). The relationship between h**5** and D is as follows:

$$h5>D/2$$

where D represents a diameter of the engagement part **110***a* of the double torsion coil spring **110** due to later-discussed reasons.

FIGS. **9**A to C are operation explanatory diagrams of an operation status of the pull-in part **100** when the sheet supply cassette **50** moves in the arrow D direction from the pull-out position illustrated by the dotted lines in FIG. **2** to the installation position illustrated by the solid lines in FIG. **2**. The operation of the pull-in part **100** is explained with reference to FIGS. **9**A to C (operation explanatory diagrams).

The pull-in part **100** is configured as explained in FIG. **8**B. Therefore, in FIGS. **9**A to C, the relationship among heights Y**1**, Y**2** and Y**3** is as follows:

$$Y2>Y3>Y1$$

where Y**1** is a height from a swing center **210** of the double torsion coil spring **110** to the engagement part **110***a* of the double torsion coil spring **110** when the double torsion coil spring **110** waits illustrated in FIG. **9**A; Y**2** is a height from the swing center **210** of the double torsion coil spring **110** to each of the pair of first horizontal parts **101***g* of the guide member **101**; and Y**3** is a height from the swing center **210** of the double torsion coil spring **110** to the upper flat surface **55***d* of the engagement member **55** of the sheet supply cassette **50**. Accordingly, the engagement member **55** inserts into the groove part **101***a* (see FIG. **6**B) of the guide member **101**, and the engagement surface **55***a* abuts on the engagement part **110***a* of the double torsion coil spring **110**.

In the wait status illustrated in FIG. **9**A, the engagement part **110***a* of the double torsion coil spring **110** generates the bias force F in the arrow F direction while the engagement part **110***a* thereof abuts on, stops at, and is compressed by the guide member **101** and the fixing member **201**. From the status, when the engagement member **55** moves in the arrow D direction with the movement of the sheet supply cassette **50**, the engagement surface **55***a* thereof abuts on the engagement part **110***a* of the double torsion coil spring **110**. When the sheet supply cassette **50** further moves in the arrow D direction, the engagement surface **55***a* thereof resists the bias force F of the double torsion coil spring **110**, moves the engagement part **110***a* in the arrow D direction, and the engagement part **110***a* reaches a dead center position below the swing center **210** in a vertical direction. FIG. **9**B illustrates a dead center position status (one embodiment of second status) in which the engagement part **110***a* has reached the dead center position. The dead center status and position are defined as status and position where the bias force G is applied only in minus Y direction that is perpendicular to Z and X directions.

During the movement, the engagement part **110***a* moves while the engagement part **110***a* is guided by the second horizontal part **101***h*, the incline part **101***f* and the first horizontal part **101***g* of the guide member **101**. The engagement part **110**_a_ is enclosed by the other engagement surface **55**_b_ of the groove part **55**_h_ (see FIG. **5**) of the engagement member **55**, and is accommodated in the groove part **55**_h_ while the engagement part **110**_a_ travels downwardly along the incline part **101**_f_.

At the dead center position, since a bias force G of the double torsion coil spring **110** works on the first horizontal part **101**_g_ that guides the engagement part **110**_a_ in the vertical direction, a bias force Fz (see FIG. **8**A) becomes zero in the direction of the movement of the engagement part **110**_a_. When the engagement part **110**_a_ further moves from the dead center position to the downstream side in the arrow D direction, a component force of a bias force of the double torsion coil spring **110** acts on in the arrow D direction by the movement thereof in the arrow D direction. Thereby, the engagement part **110**_a_ thereof presses the other engagement surface **55**_b_ of the engagement member **55**.

Thereby, the sheet supply cassette **50** moves in the arrow D direction only by a pressing force of the bias force of the double torsion coil spring **110** or by a resultant force of the pressing force and a force of the user that pushes the sheet supply cassette **50**. The installation positioning surface **58** (FIG. **2**) of the cassette cover **52** reaches the installation position in which the installation positioning surface **58** abuts on the abutment part **202** (FIG. **2**) fixed to the image forming apparatus **1** main body. FIG. **9**C illustrates the installation status (third status) in which the pull-in part **100** grasps the engagement member **55** at this time. Herein, directions toward which the engagement member **110**_a_ swings, which are illustrated from FIG. **9**A to FIG. **9**C, are defined as a first direction. Y direction means a displacement direction of the engagement part **110**_a_ (or a direction along which the first part of the biasing member moves). X direction means an axis direction of the swing shaft. Z direction means (C-D directions) means a direction along which the sheet cassette moves. More specifically, +Z direction (or D direction) may be defined as an installation direction and −Z direction (or C direction) may be defined as a pull-out direction of the sheet cassette.

At this time, since a component force of the bias force H of the double torsion coil spring **110** acts on in the arrow D direction, the double torsion coil spring **110** transits into a status in which the engagement part **110**_a_ of the double torsion coil spring **110** biases the engagement surface **55**_b_ of the engagement member **55** in the arrow D direction, and positions the cassette cover **52** at the installation position illustrated by the solid lines in FIG. **2**.

The relationship among distances L**0**, L**1**, L**2** and L**3** is as follows:

$$L0>L1>L2 \text{ and } L0>L3>L2$$

where

L**1** is a distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110**_a_ of the double torsion coil spring **110** in the wait status illustrated in FIG. **9**A; L**2** is a distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110**_a_ of the double torsion coil spring **110** in the dead center position status illustrated in FIG. **9**B; L**3** is a distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110**_a_ of the double torsion coil spring **110** in the installation status illustrated in FIG. **9**C; and L**0** is a distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110**_a_ of the double torsion coil spring **110** in the natural status. Sizes of L**1** and L**3** are configured so that the distance between L**1** and L**2** and the distance between L**3** and L**2** are small as much as possible in order to improve the handling during transitions from the wait status to the installation status and the installation status to the wait status, respectively.

An operation of the pull-in part **100**, when the sheet supply cassette **50** is pulled out, is opposite to that when the sheet supply cassette **50** is moved in the installation direction described above. Namely, the user needs to resist the bias force of the double torsion coil spring **110** and to pull out the sheet supply cassette **50** from the installation status in FIG. **9**C to the dead center position status in FIG. **9**B. However, after that, the user pulls out the sheet supply cassette **50** to the wait position in FIG. **9**A only with a bias force of the double torsion coil spring **110** in the arrow C direction, or the user receives the force and pulls out the sheet supply cassette **50** to the wait position.

As explained above, when the user installs the sheet supply cassette **50**, the user pushes the sheet supply cassette **50** from the pull-out position illustrated by the dotted lines in FIG. **2** before the engagement member **55** abuts on the double torsion coil spring **110** in the wait status illustrated in FIG. **9**A. The user resists the bias force of the double torsion coil spring **110** and further pushes the sheet supply cassette **50** before the engagement part **110**_a_ overreaches the dead center position illustrated in FIG. **9**B. Thereby, the sheet supply cassette **50** is positioned at the installation position. In the meantime, when the user pulls out the sheet supply cassette **50**, the user resists the bias force of the double torsion coil spring **110** and pulls out the sheet supply cassette **50** before the engagement member **55** overreaches the dead center position status in FIG. **9**B. Thereby, the user pulls out the sheet supply cassette **50** to the wait status illustrated in FIG. **9**A. As shown in FIGS. **9**A to **9**C, the double torsion coil spring **110** (as a bias member) provides a bias force F in the pull-out direction (C) at the pull out position . . . the spring **110** provides another bias force F in the installation direction (D) at the installation position.

In the present embodiment, as illustrated in FIG. **2**, the sheet supply cassette **50** is held between the pull-out position (illustrated by the dotted lines in FIG. **2**) and the installation position (illustrated by the solid lines in FIG. **2**) so that the sheet supply cassette **50** slides in the arrow C and D directions along the Z axis. However, the sheet supply cassette **50** may be configured to be separated and removed from the image forming apparatus **1** main body at the pull-out position.

Moreover, in the present embodiment, as illustrated in FIG. **8**B, the bottom part **55**_c_ of the groove part of the engagement member **55** is configured so that the height of the bottom part **55**_c_ is lower than that of the first horizontal part **101**g of the guide member **101**. However, the present invention is not limited thereto. The height of the bottom part **55**_c_ may be configured so that the height of the bottom part **55**_c_ is the same as or higher than that of the first horizontal part **101**_g_. By configuring as described above, the component force of the bias force of the double torsion coil spring **110**, which works below, acts on the bottom part **55**_c_, and an effect to press the cassette cover **52** below. Thereby, the cassette cover **52** is stably positioned at the installation position.

FIG. **10** is a graph illustrating a force generated by the double torsion coil spring **110** in the arrow C and D directions (Z axis direction). The force is calculated according to the position of the engagement part **110**_a_ of the double torsion coil spring **110** in the Z axis direction. Z**1** is 15 mm, Z**2** is 30 mm, and Y**2** is 30 mm, which are illustrated in FIGS. **9**A to C. Values on the horizontal axis indicate the movement distance of the engagement part **110**_a_ of the double torsion coil spring **110** from the wait status in the Z axis direction. Values on the vertical axis indicate the horizontal component force of the bias force generated by the double torsion coil spring **110**.

The arrow D direction is indicated as plus, and the arrow C direction is indicated as minus.

As illustrated in FIG. **10**, a direction of the force generated by the double torsion coil spring **110** is reversed with respect to the directions of the installation and removal of the cassette at the value of 15 mm on the horizontal axis (dead center position status). In the installation status, the force is generated in the direction in which the sheet supply cassette **50** is biased in the installation position. The recording sheets are supplied when the sheet supply cassette **50** is at the installation position. On the other hand, in the wait status, the force is generated in the direction in which the sheet supply cassette **50** is pulled out.

As illustrated in FIG. **9**, since the bias force H generated in the installation status biases the sheet supply cassette **50** in the arrow D direction, and biases the sheet supply cassette **50** vertically and below (minus direction of the Y axis) at the same time, the sheet supply cassette **50** is accurately held at the installation position in the Y axis direction.

As described above, according to the image forming apparatus of the present embodiment, the sheet supply cassette **50** is positioned at the installation position by the bias force of the double torsion coil spring **110**. Therefore, the sheet supply cassette **50** is securely held in the horizontal and vertical directions without especially providing a positioning mechanism. Moreover, when the sheet supply cassette **50** is installed or removed, a bias force assists the installation and removal.

Second Embodiment

FIGS. **11**A to C are views of a configuration of an engagement member **355**. The engagement member **355** is employed to an image forming apparatus according to a second embodiment based on the present invention. FIGS. **12**A and B are views of a configuration of a guide member **301**. The guide member **301** is employed to the image forming apparatus according to the second embodiment based on the present invention. FIGS. **13**A to C are operation explanatory diagrams of a pull-in part **300** according to the second embodiment based on the present invention. The pull-in part **300** employees the engagement member **355** and the guide member **301**. Shapes of the engagement member **355** and the guide member **301**, and an operation of the pull-in part **300** are mainly different from those of the above-described pull-in part **100** of the first embodiment illustrated in FIG. **9**.

Accordingly, the same reference numbers are put to, and explanation and figures are omitted for parts of the image forming apparatus employing the pull-in part **300** that are common with the image forming apparatus **1** of the first embodiment described above (see FIG. **1**). Parts different from those of the first embodiment are intensively explained. The main configuration of the image forming apparatus of the present embodiment is the same as that of the image forming apparatus **1** of the first embodiment illustrated in FIG. **1** other than the pull-in part **300**. Therefore, FIGS. **1** to **4** are referred if needed.

FIG. **11**A is a front view of the configuration of the engagement member **355**. FIG. **11**B is a plain view of the configuration of the engagement member **355**. FIG. **11**C is a side elevation view of the configuration of the engagement member **355** from right side.

As illustrated in FIG. **11**A, the engagement member **355** is symmetrically formed with respect to the above-described engagement member **55** of the first embodiment illustrated in FIG. **5** in the vertical direction. Namely, the engagement member **355** is a substantially cuboid member that extends in the Z axis direction. A groove part **355***h* is formed in the lower side of the engagement member **355** in the vicinity of the front edge part thereof in a width direction (X axis direction). The groove part **355***h* is formed as a border between a lower flat surface **355***f* and an lower flat surface **355***d*. The lower flat surface **355***f* is formed on the engagement member **355** on the arrow C side (sheet supply cassette **50** side). The lower flat surface **355***d* is formed on the engagement member **355** on the arrow D side (front edge side of the engagement member **355**). The lower flat surface **355***d* is a predetermined distance **h1** higher than the lower flat surface **355***f*. Wedge-shaped both sides of the engagement member **355** in the front edge side narrow along the front edge thereof.

An engagement surface **355***a* (first surface) of the groove part **355***h* is a wall on the arrow C side. An engagement surface **355***b* (second surface) of the groove part **355***h* is a wall on the arrow D side. The engagement surfaces **355***a* and **355***b* face each other through a bottom part **355***c* therebetween, and are formed vertically to the Z axis. As discussed later, when the engagement member **355** moves, the engagement surfaces **355***a* and **355***b* engage with the engagement part **110***a* of the double torsion coil spring **110**. The engagement part **110***a* and the engagement surfaces **355***a* and **355***b* act on each other.

FIG. **12**A is a front view of a configuration of the guide member **301**. FIG. **12**B is a side elevation view of the configuration of the guide member **301** from left side. The guide member **301** is fixed to and held by the guide support member **107** (see FIG. **4**).

As illustrated in FIG. **12**B, the guide member **301** includes a cross-sectional surface formed in a C-shape. The left and right guide walls **301***b* and **301***c* as well as the bottom part **301***d* of the guide member **301** form a groove part **301***a*. The engagement member **355** that moves in the arrow D direction inserts into the groove part **301***a* when the sheet supply cassette **50** moves in the installation direction. The engagement member **355** moves on the bottom part **301***d* while the left and right guide walls **301***b* and **301***c* restricts the engagement member **355**.

The guide walls **301***b* and **301***c* are opposed to and symmetrically formed with respect to each other. The guide walls **301***b* and **301***c* include a horizontal part **301***g* and an incline part **301***f*, respectively. An upper surface of each horizontal part **301***g* is formed at an h**7** height from the bottom part **301***d*, and extends from an edge part on the arrow D direction to a position in which the horizontal part **301***g* exceeds a center part. The incline part **301***f* includes a gentle incline surface that connects an edge part of the horizontal part **301***g* on the arrow C direction and an edge part of each of the guide walls **301***b* and **301***c* on the arrow C direction. The difference between both edge parts of the incline part **301***f* is h**8**.

FIGS. **13**A to C are operation explanatory diagrams of an operation status of the pull-in part **300** when the sheet supply cassette **50** moves in the arrow D direction from the pull-out position illustrated by the dotted lines in FIG. **2** to the installation position illustrated by the solid lines in FIG. **2**.

In FIGS. **13**A to C, the relationship among heights Y**1**, Y**2** and Y**3** is as follows:

$$Y2>Y3>Y1$$

where Y**1** is a height from a swing center **210** of the double torsion coil spring **110** to the engagement part **110***a* of the double torsion coil spring **110** when the double torsion coil spring **110** waits illustrated in FIG. **13**A; Y**2** is a height from the swing center **210** of the double torsion coil spring **110** to each of the pair of horizontal parts **301***g* of the guide member **301**; and Y**3** is a height from the swing center **210** of the double torsion coil spring **110** to the lower flat surface **355***d* of the engagement member **355** of the sheet supply cassette **50**. Thereby, the engagement member **355** inserts into the groove part **301***a* (FIG. **12**B) of the guide member **301**, and the engagement surface **355***a* abuts on the engagement part **110***a* of the double torsion coil spring **110**.

The operation of the pull-in part **300** is explained with reference to FIGS. **13**A to C (operation explanatory diagrams).

In the wait status illustrated in FIG. **13**A, the engagement part **110***a* of the double torsion coil spring **110** generates the bias force K in the arrow K direction while the engagement part **110***a* thereof abuts on, stops at, and is compressed by the guide member **301** and the fixing member **201**. From the status, when the engagement member **355** moves in the arrow D direction with the movement of the sheet supply cassette **50**, the engagement surface **355***a* thereof abuts on the engagement part **110***a* of the double torsion coil spring **110**, resists the bias force K of the double torsion coil spring **110**, moves the engagement part **110***a* thereof in the arrow D direction, and the engagement part **110***a* thereof reaches a dead center position below the swing center **210** in a vertical direction. FIG. **13**B illustrates a dead center position status in which the engagement part **110***a* has reached the dead center position.

During the movement, the engagement part **110***a* moves while the engagement part **110***a* is guided by the incline part **301***f* and the horizontal part **301***g* of the guide member **301**. The engagement part **110***a* is enclosed by the other engagement surface **355***b* of the groove part **355***h* of the engagement member **355**, and is accommodated in the groove part **355***h* while the engagement part **110***a* travels upwardly along the incline part **301***f*.

At the dead center position, since a bias force G of the double torsion coil spring **110** works on the horizontal part **301***g* that guides the engagement part **110***a* in the vertical direction, a bias force becomes zero in the direction of the movement of the engagement part **110***a*. When the engagement part **110***a* further overreaches the dead center position, a component force of a bias force of the double torsion coil spring **110** acts on in the arrow D direction by the movement thereof in the arrow D direction. Thereby, the engagement part **110***a* thereof presses the other engagement surface **355***b* of the engagement member **355**.

Thereby, the sheet supply cassette **50** moves in the arrow D direction only by the pressing force or by a resultant force of the pressing force and a force of the user that pushes the sheet supply cassette **50**. The installation positioning surface **58** (see FIG. **2**) of the cassette cover **52** reaches the installation position, and abuts on the abutment part **202** (see FIG. **2**) fixed to the image forming apparatus **1** main body. FIG. **13**C illustrates the installation status in which the pull-in part **300** grasps the engagement member **355** at this time.

At this time, since a component force of the bias force M of the double torsion coil spring **110** acts on in the arrow D direction, the double torsion coil spring **110** transits into a status in which the engagement part **110***a* of the double torsion coil spring **110** biases the engagement surface **355***b* of the engagement member **355** in the arrow D direction, and positions the cassette cover **52** at the installation position illustrated by the solid lines in FIG. **2**.

Moreover, when the double torsion coil spring **110** is in the status in FIG. **13**C, the preferable relationship among Fd, μ, and N is as follows:

$$Fd>\mu\cdot N$$

where Fd is the component force of the bias force M of the double torsion coil spring **110** in the arrow D direction; μ is a dynamic friction coefficient between the sheet supply cassette **50** and the holder **31***a* and **31***b* (see FIG. **1**); and N is a weight of the sheet supply cassette **50**.

Moreover, in order to more securely allow the sheet supply cassette **50** to transit from the status in FIG. **13**B into FIG. **13**C, the preferable relationship among Fd, μ', and N is as follows:

$$Fd>\mu'\cdot N$$

where μ' is a static friction coefficient between the sheet supply cassette **50** and the holder **31***a* and **31***b* (see FIG. **1**).

The relationship among distances L**0**, L**1**, L**2** and L**3** is as follows:

$$L0>L1>L2 \text{ and } L0>L3>L2$$

where L**1** is a distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110***a* of the double torsion coil spring **110** in the wait status illustrated in FIG. **13**A; L**2** is a distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110***a* of the double torsion coil spring **110** in the dead center position status illustrated in FIG. **13**B; L**3** is a distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110***a* of the double torsion coil spring **110** in the installation status illustrated in FIG. **13**C; and L**0** is the distance between the swing center **210** of the double torsion coil spring **110** and the engagement part **110***a* of the double torsion coil spring **110** in the natural status. Sizes of L**1** and L**3** are configured so that the distance between L**1** and L**2** and the distance between L**3** and L**2** are small as much as possible in order to improve the handling during transitions from the wait status to the installation status and the installation status to the wait status, respectively.

An operation of the pull-in part **300**, when the sheet supply cassette **50** is pulled out, is opposite to that when the sheet supply cassette **50** is moved in the installation direction described above. Namely, the user needs to resist the bias force of the double torsion coil spring **110** and to pull out the sheet supply cassette **50** from the installation status in FIG. **13**C to the dead center position status in FIG. **13**B. However, after that, the user pulls out the sheet supply cassette **50** to the wait position in FIG. **13**A only with a bias force of the double torsion coil spring **110** in the arrow C direction, or the user receives the force and pulls out the sheet supply cassette **50** to the wait position.

As explained above, when the user installs the sheet supply cassette **50**, the user pushes the sheet supply cassette **50** from the pull-out position illustrated by the dotted lines in FIG. **2** before the engagement member **355** abuts on the double torsion coil spring **110** in the wait status illustrated in FIG. **13**A. The user resists the bias force of the double torsion coil spring **110** and further pushes the sheet supply cassette **50** before the engagement part **110***a* overreaches the dead center position illustrated in FIG. **13**B.

Thereby, the sheet supply cassette **50** is positioned at the installation position. In the meantime, when the user pulls out the sheet supply cassette **50**, the user resists the bias force of the double torsion coil spring **110** and pulls out the sheet supply cassette **50** before the engagement member **355** overreaches the dead center position status in FIG. **13**B. Thereby, the user pulls out the sheet supply cassette **50** to the wait status illustrated in FIG. **13**A.

As described above, according to the image forming apparatus of the present embodiment, the sheet supply cassette **50** is positioned at the installation position by the bias force of the double torsion coil spring **110**. Therefore, the sheet supply cassette **50** is securely held in the horizontal direction without especially providing a positioning mechanism. Moreover, when the sheet supply cassette **50** is installed or removed, a bias force assists the installation and removal.

Third Embodiment

FIGS. **14**A to C are views of a configuration of an engagement member **455**. The engagement member **455** is employed to an image forming apparatus according to a third embodiment based on the present invention. FIGS. **15**A to C are views of a configuration of a guide member **401**. The guide member **401** is employed to the image forming apparatus according to the third embodiment based on the present invention. FIGS. **16**A and B are operation explanatory diagrams of operations of the engagement member **455** with respect to the guide member **401** according to the third embodiment based on the present invention. The image forming apparatus employees the engagement member **455** and the guide member **401**. Only shapes of the engagement member **455** and the guide member **401** are mainly different from those of the above-described image forming apparatus of the first embodiment illustrated in FIG. **1**.

Accordingly, the same reference numbers are put to, and explanation and figures are omitted for parts of the image forming apparatus employing the engagement member **455** and the guide member **401** that are common with the first embodiment mentioned above (see FIG. **1**). Parts different from those of the first embodiment are intensively explained. The main configuration of the image forming apparatus of the present embodiment is the same as that of the image forming apparatus **1** of the first embodiment illustrated in FIG. **1** other than the pull-in part. Therefore, FIGS. **1** to **4** are referred if needed. In other words, the spring **110** (or biasing member) maintains to provide the bias force against the guide restriction member **101** regardless of its position. For example, the spring **110** provides the bias force at the pull-out position as well as at the installation position. Further, it is preferred that the bias force of the spring **110** at the installation position is greater than a maximum static frictional force of the sheet supply cassette **50** acting on the apparatus main body.

FIG. **14**A is a front view of the configuration of the engagement member **455**. FIG. **14**B is a plain view of the configuration of the engagement member **455**. FIG. **14**C is a side elevation view of the configuration of the engagement member **455** from right side.

As illustrated FIGS. **14**A to C, the engagement member **455** is a substantially cuboid member that extends in the Z axis direction. A groove part **455***h* is formed in the upper side of the engagement member **455** in the vicinity of the front edge part thereof in a width direction (X axis direction). The groove part **455***h* is formed as a border between an upper flat surface **455***f* and an upper flat surface **455***d*. The upper flat surface **455***f* is formed on the engagement member **455** on the arrow C side (sheet supply cassette **50** side). The upper flat surface **455***d* is formed on the engagement member **455** on the arrow D side (front edge side of the engagement member **455**). The upper flat surface **455***d* is a predetermined distance h**1** lower than the upper flat surface **455***f*. Wedge-shaped both sides of the engagement member **455** in the front edge side narrow along the front edge thereof. An engagement surface **455***a* (first surface) of the groove part **455***h* is a wall on the arrow C side. An engagement surface **455***b* (second surface) of the groove part **455***h* is a wall on the arrow D side. The engagement surfaces **455***a* and **455***b* face each other through a bottom part **455***c* therebetween, and are formed substantially vertically. When the engagement member **455** moves, the engagement surfaces **455***a* and **455***b* engage with the engagement part **110***a* of the double torsion coil spring **110**. The engagement part **110***a* and the engagement surfaces **455***a* and **455***b* act on each other.

Projection part **445***j* and **445***k* are formed at the lowest parts of both of side surfaces from an end point to a position separated distance w**1** in the Z axis direction from a front edge part of the engagement member **455**. The projection parts **445***j* and **445***k* project in the width direction (X axis direction).

FIG. **15**A is a front view of a configuration of the guide member **401**. FIG. **15**B is a plain view of the configuration of the guide member **401** from left side. FIG. **15** C is a side elevation view of the configuration of the guide member **401** from left side. The guide member **401** is fixed to and held by the guide support member **107** (see FIG. **4**).

As illustrated in FIG. **15**C, the guide member **401** includes a cross-sectional surface formed in a C-shape. The left and right guide walls **401***b* and **401***c* as well as the bottom part **401***d* of the guide member **401** form a groove part **401***a*. The engagement member **455** that moves in the arrow D direction inserts into the groove part **401***a* when the sheet supply cassette **50** moves in the installation direction. The engagement member **455** moves on the bottom part **401***d* while the left and right guide walls **401***b* and **401***c* restricts the engagement member **455**.

The guide walls **401***b* and **401***c* are opposed to and symmetrically formed with respect to each other. The guide walls **401***b* and **401***c* include a horizontal part **401***g*, an incline part **401***f* and a lock part **401***h*, respectively. An upper surface of each horizontal part **401***g* is formed at an h**4** height from the bottom part **401***d*, and extends from an edge part on the arrow D direction to a position in which the horizontal part **401***g* exceeds a center part. The incline part **401***f* includes an incline surface that is formed to continue from the horizontal part **401***g* and to gently curbs upwardly in the arrow C direction. The lock part **401***h* is formed to continue from the incline part **401***f*.

Moreover, engagement parts **401***j* and **401***k* are formed on the guide walls **401***b* and **401***c*, respectively. The engagement parts **401***j* and **401***k* protrude to face and approach each other along the Z axis direction from a position of the incline part **401***f* that extends in the Z axis direction to an edge part on the arrow C direction.

Operations of the engagement member **455** with respect to the guide member **401** are explained with reference to FIGS. **16**A and B (operation explanatory diagrams).

FIG. **16**A illustrates a status in which the engagement member **455** starts to enter into the groove part **401***a* of the guide member **401** while the sheet supply cassette **50** moves in the arrow D direction from the pull-out position illustrated by the dotted lines in FIG. **2** to the installation position illustrated by the solid lines in FIG. **2**. FIG. **16**B illustrates a status in which the sheet supply cassette **50** has reached the installation position.

As illustrated in FIGS. **16**A and B obviously, projection parts **455***j* and **455***k* of the engagement member **455** abut on the engagement parts **401***j* and **401***k* of the guide member **401**, and the sheet supply cassette **50** is positioned at a position on the X axis direction with respect to the image forming apparatus **1** main body while the engagement member **455** moves in the arrow D direction on the groove part **401***a* of the guide member **401**.

As the present embodiment, when the projection parts **455***j* and **455***k* as well as the engagement parts **401***j* and **401***k* are employed to the engagement member **55** and the guide member **101** the above-described first embodiment, for example, the projection parts **455***j* and **455***k* preferably abut on the engagement parts **401**j and **401**k in a zone between the dead center position status illustrated in FIG. **9**B and an installation status illustrated in FIG. **9**C. Namely, the projection parts **455**j and **455**k as well as the engagement parts **401**j and **401**k are preferably configured to form an installation positioning region H illustrated in FIG. **16**B. In the zone, as described above, since the component force of the bias force of the double torsion coil spring **110** acts on in the arrow D direction, a load of sliding during the installation movement by the above-described abutment is lessened.

The position w**1** of the projection parts **445**j and **445**k from the front edge part of the engagement member **455** illustrated in FIG. **14**A are determined after the timing at which the engagement parts **401**j and **401**k of the guide member **401** start to abut is considered as described above.

As described above, according to the image forming apparatus of the present invention, the sheet supply cassette **50** is accurately positioned at a position on the X axis direction with respect to the image forming apparatus **1** main body before the sheet supply cassette **50** reaches the installation position. Therefore, the position accuracy at the installation position is improved. Moreover, the load of sliding during the installation movement is lessened.

Fourth Embodiment

FIG. **17**A is a perspective view of a configuration of a pull-in part **500**. FIG. **17**B is an exploded perspective view of the configuration of the pull-in part **500**. The pull-in part **500** is employed to the image forming apparatus according to a fourth embodiment based on the present invention. Shapes of a swing support member **504**, a guide member **501** and an engagement member **555** as well as an operation of the pull-in part **500** are mainly different from those of the above-described pull-in part **100** of the first embodiment illustrated in FIG. **4**.

Accordingly, the same reference numbers are put to, and explanation and figures are omitted for parts of the image forming apparatus employing the pull-in part **500** that are common with the image forming apparatus **1** the first embodiment mentioned above (see FIG. **1**). Parts different from those of the first embodiment are intensively explained. The main configuration of the image forming apparatus of the present embodiment is the same as that of the image forming apparatus **1** of the first embodiment illustrated in FIG. **1** other than the pull-in part **500**. Therefore, FIGS. **1** to **4** are referred if needed.

In FIG. **17**, a swing support member **504** and a guide support member **107** formed in a C-shape are fixed to the fixing member **201** (see FIG. **2**) fixed to the image forming apparatus **1** main body. A pair of arch holes **504**a that face each other are formed on surfaces of the swing support member **504** that face each other. Shaft couplings **508**a and **508**b are slidably held on both edge part of the spring shaft (support part) **506** by the pair of arch holes **504**a. The shaft couplings **508**a and **508**b are rotatably attached to the spring shaft **506**. A double torsion coil spring **110** is rotatably supported by a spring shaft **506**. As discussed later, each of the arch holes **504**a includes a guide center that is formed in an arc shape and has a radius R**1**. The pair of the arch holes **504**a guide the shaft couplings **508**a and **508**b.

A guide member **501** is fixed to the guide support member **107**. As discussed later, the guide member **501** guides the engagement part **110**a of the double torsion coil spring **110**. The engagement part **110**a engages with the engagement member **555** of the sheet supply cassette **50**. The engagement member **555** moves in a groove part **501**a.

Here, detailed explanation regarding the guide member **501** used in the present embodiment is omitted since the guide member **501** has the same shape as the guide member **401** illustrated in FIG. **15** explained in the above-described third embodiment. As discussed later, the incline part **501**f is formed in an arc shape and has a radius R**2**.

Here, detailed explanation regarding the engagement member **555** used in the present embodiment is omitted since the engagement member **555** has the same shape as the engagement member **455** illustrated in FIG. **14** explained in the above-described third embodiment.

FIGS. **18**A to C are operation explanatory diagrams of an operation status of the pull-in part **500** when the sheet supply cassette **50** moves in the arrow D direction from the pull-out position illustrated by the dotted lines in FIG. **2** to the installation position illustrated by the solid lines in FIG. **2**.

In FIGS. **18**A to C, the relationship among heights Y**1**, Y**2** and Y**3** is as follows:

$$Y2>Y3>Y1$$

where Y**1** is a height from a swing center **510** of the double torsion coil spring **110** to the engagement part **110**a of the double torsion coil spring **110** when the double torsion coil spring **110** waits illustrated in FIG. **18**A; Y**2** is a height from the swing center **510** of the double torsion coil spring **110** to the pair of horizontal parts **501**g of the guide member **101**; and Y**3** is a height from the swing center **510** of the double torsion coil spring **110** to the upper flat surface **555**d of the engagement member **555** of the sheet supply cassette **50**.

Thereby, the engagement member **555** inserts into the groove part **501**a (see FIG. **17**B) of the guide member **501**, and an engagement surface **555**a (first surface) abuts on the engagement part **110**a of the double torsion coil spring **110**.

Moreover, the guide center of the arch hole **504**a of the swing support member **504** and the incline part **501**f of the guide member **501** are arranged on a concentric circle as illustrated in FIG. **18**C. The guide center is formed in an arc shape and has the radius R**1**. The incline part **501**f is formed in an arc shape and has the radius R**2**. Accordingly, the length of the radius R**1** is the same as the radius R**2**.

The operation of the pull-in part **500** is explained with reference to FIGS. **18**A to C (operation explanatory diagrams).

In the wait status illustrated in FIG. **18**A, the engagement part **110**a of the double torsion coil spring **110** generates the bias force P in the arrow P direction while the engagement part **110**a thereof abuts on and stops at the lowest part of the lock part **501**h of the guide member **501**. From the status, when the engagement member **555** moves in the arrow D direction with the movement of the sheet supply cassette **50**, the engagement surface **555**a thereof abuts on the engagement part **110**a of the double torsion coil spring **110**, resists the bias force P of the double torsion coil spring **110**, moves the engagement part **110**a thereof in the arrow D direction, and the engagement part **110**a thereof reaches a dead center position below the swing center **510** in a vertical direction. FIG. **18**B illustrates a dead center position status in which the engagement part **110**a has reached the dead center position.

The guide center of the arch hole **504**a and the incline part **501**f are arranged on the concentric circle. Therefore, while the engagement part **110**a has reached the dead center position status from the wait status, the engagement part **110**a is guided by the incline part **501**f, and moves to a border between a horizontal part **501**g and the incline part **501**f. The swing center **510** of the double torsion coil spring **110** moves from an end P**1** (first support position) of the arch hole **504**a illustrated in FIG. **18**A to a center part P**2** illustrated in FIG.

18B. The swing center **510** corresponds to a position of the spring shaft **506**. The center part P**2** corresponds to a highest part of the arch hole **504***a*. The engagement part **110***a* and the swing center **510** moves as described above since the compressed double torsion coil spring **110** acts on to return to the natural status.

The relationship between distances L**1** and L**2** is L**1**=L**2** where L**1** is a distance between the swing center **510** of the double torsion coil spring **110** and the engagement part **110***a* of the double torsion coil spring **110** in the wait status illustrated in FIG. **18**A; and L**2** is a distance between the swing center **510** of the double torsion coil spring **110** and the engagement part **110***a* of the double torsion coil spring **110** in the dead center position status illustrated in FIG. **18**B. When the double torsion coil spring **110** moves between P**1** and P**2**, the swing center **510** and the engagement part **110***a* keep the same distance therebetween and the double torsion coil spring **110** do not be compressed. Therefore, a load during the movement from the wait status to the dead center position is lessened. The engagement part **110***a* is enclosed by the other engagement surface **555***b* (second surface) of the groove part **555***h* of the engagement member **555**, and is accommodated in the groove part **555***h* while the engagement part **110***a* travels downwardly along the incline part **101***f*.

At the dead center position, since a bias force G of the double torsion coil spring **110** works on the horizontal part **501***g* that guides the engagement part **110***a* in the vertical direction, a bias force becomes zero in the direction of the movement of the engagement part **110***a*. When the engagement part **110***a* overreaches the dead center position, a component force of the bias force of the double torsion coil spring **110** acts on in the arrow D direction by the movement thereof in the arrow D direction. Thereby, while the engagement part **110***a* thereof presses the other engagement surface **555***b* of the engagement member **555**, the swing center **510** moves to an other end P**3** (second support position) of the arch hole **504***a*.

Therefore, the sheet supply cassette **50** moves in the arrow D direction only by a pressing force of the bias force of the double torsion coil spring **110** or by a resultant force of the pressing force and a force of the user that pushes the sheet supply cassette **50**. The installation positioning surface **58** (see FIG. **2**) of the cassette cover **52** reaches the installation position, and abuts on the abutment part **202** (see FIG. **2**) fixed to the image forming apparatus **1** main body. FIG. **18**C illustrates the installation status in which the pull-in part **500** grasps the engagement member **555** at this time.

At this time, since a component force of the bias force Q of the double torsion coil spring **110** acts on in the arrow D direction, the double torsion coil spring **110** transits into a status in which the engagement part **110***a* of the double torsion coil spring **110** biases the engagement surface **555***b* of the engagement member **555** in the arrow D direction, and positions the cassette cover **52** at the installation position illustrated by the solid lines in FIG. **2**.

The relationship among distances L**0**, L**1**, L**2** and L**3** is as follows:

$$L0>L3>L1=L2$$

where

L**3** is a distance between the swing center **510** of the double torsion coil spring **110** and the engagement part **110***a* of the double torsion coil spring **110** in the installation status illustrated in FIG. **18**C.

An action of the operation of the pull-in part **500**, when the sheet supply cassette **50** is pulled out, is opposite to that when the sheet supply cassette **50** is moved in the installation direction described above. Namely, the user resists the bias force of the double torsion coil spring **110**, and pulls out the sheet supply cassette **50** from the installation status in FIG. **18**C to the dead center position status in FIG. **18**B. After that, the user receives a weak bias force of the double torsion coil spring **110** in the arrow C direction, and pulls out the sheet supply cassette **50** to the wait position in FIG. **18**A.

FIG. **19** is a graph illustrating a force generated by the double torsion coil spring **110** in the arrow C and D directions (Z axis direction). The force is calculated according to the position of the engagement part **110***a* of the double torsion coil spring **110** in the Z axis direction in the present embodiment. Z**1** is 15 mm, Z**2** is 30 mm and Y**2** is 30 mm in the same manner as the above-described first embodiment, and Z**3** is 15 mm, which are illustrated in FIGS. **18**A to C. Values on the horizontal axis indicate the movement distance of the engagement part **110***a* of the double torsion coil spring **110** from the wait status in the Z axis direction. Values on the vertical axis indicate the horizontal component force of the bias force generated by the double torsion coil spring **110**. The arrow D direction is indicated as plus, and the arrow C direction is indicated as minus. For comparison, FIG. **19** also illustrates a graphed example of the force in pull-in part **100** of the first embodiment, which is illustrated in FIG. **10**, calculated in the same manner as the fourth embodiment.

As illustrated in FIG. **19**, according to the pull-in part **500** according to the present embodiment, a needed space in the Z axis direction from the wait status to the installation status is shorten from 45 mm to 30 mm in comparison with the configuration of the pull-in part **100** according to the first embodiment. The shorten amount is equal to a movement distance Z**3** (i.e., 15 mm) of the swing center **510** of the double torsion coil spring **110**.

As described above, according to the image forming apparatus of the present embodiment, a stroke from the wait status to the installation status is shorten in the pull-in part. Therefore, a space to install the sheet supply cassette **50** to the image forming apparatus main body and hold the sheet supply cassette **50** in the image forming apparatus main body is shorten. Moreover, a needed work is reduced during the installation and removal of the sheet supply cassette **50**.

In each above-mentioned embodiment, the image forming apparatus that uses the four process unit and transfers the toner image on the recording medium with the intermediate transfer belt are explained as an example. However, the present invention is not limited to such an image forming apparatus, and may be implemented in an image forming apparatus that directly transfers a toner image from a process unit onto a recording medium, a monochrome image forming apparatus that uses one process unit, a photocopy machine that uses the image forming apparatuses, and an image forming apparatus included in an automatic manuscript reading device and the like.

Regarding the recording media of the present invention, there is no restriction on quality, size or material. The recording medium may be bond paper, recycled paper, gloss paper, matte paper, over-head-projector (OHP) films, which is made of plastic, or the like. Further, in the application, the recording medium is disclosed as a sheet, but the recording medium may be a roll.

What is claimed is:

1. An image forming apparatus in which a sheet supply cassette configured to stack recording media thereon slidably moves in an installation direction and a pull-out direction so that the sheet supply cassette changes its position between a pull-out position where the sheet supply cassette is pulled out from an apparatus main body and an installation position where the sheet supply cassette is installed to the apparatus main body, the image forming apparatus comprising:

an engagement member provided on the sheet supply cassette;

a biasing member that is configured with a first part formed at an end of the biasing member, a second part formed at another end of the biasing member, and an elastic part provided between the first and second parts, the biasing member applying elastic force,

the second part being supported to the apparatus main body with a shaft such that the second part swings around the shaft,

the first part engaging with the engagement member so that the biasing member maintains a compressed state by the engagement member; and

a guide restriction member provided on the apparatus main body and configured to restrict a movement of the first part in the installation direction and the pull-out direction, wherein

during a process in which the sheet supply cassette moves in the installation direction from the pull-out position toward the installation position, the biasing member swings in a first direction by the engagement member, becoming one of a first status through a third status,

in the first status, the first part has not engaged with the engagement member,

in the second status, the first part engages with the engagement member and moves in the installation direction,

in the third status, the sheet supply cassette reaches the installation position and the biasing member biases the engagement member toward the installation position.

2. The image forming apparatus according to claim **1**, wherein

the guide restriction member includes a position restriction part configured to positionally restrict the first part on an upperstream side of the second part in the installation direction when the sheet supply cassette is at the pull-out position, and

when the sheet supply cassette is at the pull-out position, the position restriction part is configured to restrict the biasing member at a position where the first part of the biasing member engages with the engagement member.

3. The image forming apparatus according to claim **2**, wherein

the engagement member includes

a groove part which is configured to engage with the first part and

a first surface which is configured to guide the first part to the groove part, and

during a process in which the sheet supply cassette moves from the pull-out position toward the installation position, the first part engages with the groove part after contacting the first surface.

4. The image forming apparatus according to claim **3**, wherein

the biasing member biases the guide restriction member in an engagement direction along which the first part and the groove part are engaged,

the guide restriction member includes a guiding part that guides the first part in the engagement direction during the process in which the sheet supply cassette moves from the pull-out position toward the installation position.

5. The image forming apparatus according to claim **4**, wherein

the guide restriction member includes a first restrict part that restricts the first part at the installation position, and a second restriction part that restricts the first part at the pull-out position, and

the guiding part is disposed between the first restriction part and the second restriction part.

6. The image forming apparatus according to claim **5**, wherein

the biasing member maintains to provide a bias force against the guide restriction member at the pull-out position as well as at the installation position.

7. The image forming apparatus according to claim **1**, wherein

during another process in which the sheet supply cassette moves in the pull-out direction from the installation position toward the pull-out position,

the biasing member becomes the first status from a fourth status which is next to the third status when the sheet supply cassette moves in the pull-out direction from the installation position, the fourth status where the first part that engages with the engagement member moves in the pull-out direction and swings in a second direction that is opposite to the first direction,

the engagement member of the sheet supply cassette separates from the first part of the biasing member, further moves in the pull-out direction, and reaches the pull-out position.

8. The image forming apparatus according to claim **7**, wherein

the first part of the biasing member is displaced in a displacement direction that is orthogonal to both of a sliding direction of the sheet supply cassette and a direction of the shaft during a transition of the biasing member from the first status to the second status and during another transition from the fourth status to the first status.

9. The image forming apparatus according to claim **1**, wherein

the engagement member includes a first surface on a side of the pull-out position and a second surface on a side of the installation position side that are formed vertically to a sliding direction of the sheet supply cassette and that face each other, and one of the first surface and the second surface abuts on the first part of the biasing member.

10. The image forming apparatus according to claim **1**, wherein

the engagement member includes a first surface on a side of the pull-out position and a second surface on a side of the installation position side that are formed vertically to a sliding direction of the sheet supply cassette and that face each other, and both of the first surface and the second surface abut on the first part of the biasing member.

11. The image forming apparatus according to claim **1**, wherein the guide restriction member restricts a movement of the engagement member in a direction of the shaft when the sheet supply cassette is at the installation position.

12. The image forming apparatus according to claim **1**, wherein

the second part of the biasing member is supported displacably between a first support position on a side of the installation direction and a second support position on a side of the pull-out direction,

during a process in which the biasing member becomes the third status from the first status, a support part of the second part is displaced from the first support position to the second support position.

13. The image forming apparatus according to claim **1**, wherein

the second part of the biasing member is supported displacably between a first support position on a side of the installation direction and a second support position on a side of the pull-out direction,

during a process in which the biasing member becomes the third status from the first status, a support part of the first part is displaced from the first support position to the second support position.

14. An image forming apparatus in which a sheet supply cassette configured to stack recording media thereon slidably moves in an installation direction and a pull-out direction so that the sheet supply cassette changes its position between a pull-out position where the sheet supply cassette is pulled out from an apparatus main body and an installation position where the sheet supply cassette is installed to the apparatus main body, the image forming apparatus comprising:

an engagement member provided on the sheet supply cassette;

a biasing member that is configured with a first part formed at an end of the biasing member, a second part formed at another end of the biasing member, and an elastic part provided between the first and second parts, the biasing member applying elastic force,

the second part being supported to the apparatus main body with a shaft such that the second part swings around the shaft,

the first part engaging with the engagement member so that the biasing member maintains a compressed state by the engagement member; and

a guide restriction member provided on the apparatus main body and configured to restrict a movement of the first part in the installation direction and the pull-out direction, wherein

the second part of the biasing member is positioned on an upstream side of the first part of the biasing member in the installation direction when the sheet supply cassette is at the installation position.

15. The image forming apparatus according to claim **14**, wherein

the guide restriction member includes a position restriction part configured to positionally restrict the first part on an upperstream side of the second part in the installation direction when the sheet supply cassette is at the pull-out position, and

the position restriction part is configured to restrict the biasing member at a position where the first part of the biasing member engages with the engagement member, when the sheet supply cassette is at the pull-out position.

16. The image forming apparatus according to claim **15**, wherein

during a process in which the sheet supply cassette moves in the installation direction from the pull-out position toward the installation position, the biasing member swings in a first direction by the engagement member, becoming one of a first status through a third status, wherein

in the first status, the first part has not been engaged with the engagement member,

in the second status, the first part engages with the engagement member and moves in the installation direction,

in the third status, the sheet supply cassette reaches the installation position and the biasing member biases the engagement member toward the installation position.

17. The image forming apparatus according to claim **14**, wherein

the engagement member is positioned at a downstream end part in the installation direction of the sheet supply cassette.

18. An image forming apparatus in which a sheet supply cassette configured to stack recording media thereon slidably moves in an installation direction and a pull-out direction so that the sheet supply cassette changes its position between a pull-out position where the sheet supply cassette is pulled out from an apparatus main body and an installation position where the sheet supply cassette is installed to the apparatus main body, the image forming apparatus comprising:

an engagement member provided on the sheet supply cassette;

a biasing member that is configured with a first part formed at an end of the biasing member, a second part formed at another end of the biasing member, and an elastic part provided between the first and second parts, the biasing member applying elastic force,

the second part being supported to the apparatus main body with a shaft such that the second part swings around the shaft,

the first part engaging with the engagement member so that the biasing member maintains a compressed state by the engagement member; and

a guide restriction member provided on the apparatus main body and configured to restrict a movement of the first part in the installation direction and the pull-out direction, wherein

the biasing member is configured to generate a bias force in the pull-out direction at the pull-out position, and

the biasing member is configured to generate another bias force in the installation direction at the installation position.

19. The image forming apparatus according to claim **18**, wherein

the guide restriction member includes a position restriction part configured to positionally restrict the first part on an upperstream side of the second part in the installation direction when the sheet supply cassette is at the pull-out position, and

the position restriction part is configured to restrict the biasing member at a position where the first part of the biasing member engages with the engagement member, when the sheet supply cassette is at the pull-out position.

20. The image forming apparatus according to claim **19**, wherein

during a process in which the sheet supply cassette moves in the installation direction from the pull-out position toward the installation position, the biasing member swings in a first direction by the engagement member, becoming one of a first status through a third status, wherein

in the first status, the first part has not been engaged with the engagement member,

in the second status, the first part engages with the engagement member and moves in the installation direction,

in the third status, the sheet supply cassette reaches the installation position and the biasing member biases the engagement member toward the installation position.

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